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ABSTRACT

The purpose of this collection of papers is to serve as a guide for the English teacher in the field of technical and scientific writing. The eight main sections concern the definition and the teaching of technical writing; the skills, needs, and goals of the technical writing student; teacher appraisal of the technical writing curriculum; practical classroom approaches to technical writing; methods for evaluating technical writing; the importance of effective technical writing in industry; and technical writing as a science and as an art. A bibliography of approximately 60 items concerning the teaching of technical writing is also included. (TS)

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The Teaching of Technical Writing

Edited by Donald H. Cunningham and Herman A. Estrin

CS 202 306

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Preface

As the demand for technical and scientific writing courses grows, teachers of English are having to assume the responsibility for teaching such courses. Those who are called on to teach these courses often find themselves faced with several questions. What is technical and scientific writing? How does it differ from other kinds of writing, especially the nonfiction prose they are teaching in freshman composition and advanced writing courses? Who are the students they will find in their classes, and what motivations for writing will they have? At what level should these courses be taught? How can the atmosphere of practical, on-the-job writing replace the aura of classroom writing? Where can teachers identify and locate resources that will help prepare them to teach these courses?

Answers to these questions are being provided by teachers of English and professional writers and editors who teach such courses. Publications have appeared—many of them very helpful. This collection brings together what are in the editors' judgements some of the most helpful articles and papers on the pedagogical concerns of technical and scientific writing. The limitations of space have caused some very good items to be omitted, but the Bibliography contains additional information in other sources. This collection will serve as a guide for the English teacher in the field of technical and scientific writing. Hopefully, it will also serve as a catalyst for generating more work in the field.

The items in this collection, written or delivered as speeches by different authorities from a variety of institutions for varying occasions and audiences, do not develop a single thesis. But they do address themselves to the central concerns of teaching technical and scientific writing, and they do maintain a consistent point of view: that the technical and scientific writing course merits a place in the curriculum and deserves the best efforts of the English-teaching profession.

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1

Technical Writing Defined

ROBERT HAYS

What Is Technical Writing?

Technical writing is not a new language, asserts the author. It shares much of the common English vocabulary with other writing, but it is more conservative, more the slave of rule than is popular prose. The greatest difference between technical and nontechnical writing is linguistic. Robert Hays heads the Department of English at Southern Technical Institute.

One of the many omens of creeping specialization has been something called "technical writing," "report writing," "engineering English," or "the technical style." And although a dean from a technical school recently remarked that there is no such animal as "technical writing," evidence shows that engineers, technicians, and their teachers and college administrators feel certain that "technical writing" exists. Courses called by the various names given to technical writing appear in many if not a preponderance of the curricula of engineering colleges and technical institutes.

Nor are course titles the only proof that technical writing is a lively subject indeed. *The National Union Catalog* lists at least 47 books since 1950 concerned with the subject. A recent research project carried out by *Encyclopaedia Britannica* easily located 27 articles dealing with technical writing; this research project was by no means definitive. A recent study sponsored by the Carnegie Corporation found that from eight to eleven percent of the curricula in technical institutes is devoted to communication courses.

What then is technical writing? What are the characteristics peculiar to the technical style? What distinguishes it—aside from content and subject matter—from prose written for lay readers or from journalese?

First, technical writing is not a new language, however much a new language might be desired. The technical style preserves the basic Teutonic word order, perhaps maintaining the subject-verb-object sequence more consistently than does prose sculptured by the literary craftsman.

Second, technical writing is probably more conservative, more the slave of the rule, than is the style of popular fiction or even such publications as *The English Journal*. A survey of company-produced publications will reveal industry and engineering devoting much time and energy to teaching their fledglings how to write *correctly*. Gideon Bibles may appear more frequently in hotel rooms; but the book beside the organization manual on the junior executive's desk will be a dictionary, and his secretary will probably have a secretarial handbook plus a dictionary. Research in linguistics may have cast serious doubt on the meaning of "correct English," but Lockheed Aircraft Corporation, General Motors Corporation, Shell Oil Company (to mention only three at random) and many other industrial giants have published guides to *correct usage*.

Third, technical writing shares much of the "common" English vocabulary. The verbs heard on trolleys and at tennis matches are also used in managerial conferences and over drawing boards; and these verbs are conjugated the same in technical writing as in other prose styles. The workhorse articles *a*, *an*, and *the* appear in reports just as they appear on the front page of the daily paper.

The question is, how does the technical style differ from other prose? There are two fundamental differences, one perhaps psychological and the other linguistic.

The psychological difference lies in the writer's attitude toward his subject. This is predominantly an attitude of utter seriousness. Technical reports avoid exaggeration, for exaggeration might cause misinterpretation of a specification or erection of a structure on the wrong side of a property line. After five o'clock engineers and technicians may be like people. But during working hours decisions often involve lives, reputations, property, the future of organizations. On the job the engineer or technician writing his report must dedicate himself to facts. The appropriate attitude is one of objectivity (if humanly possible), respect for data and their limitations, and caution.

But the greatest difference, at least for teachers and students of technical writing, is linguistic. Technical style demands a specialized vocabulary, especially in its adjectives and nouns. This difference alone would justify the study of technical writing. Only the rare course in English composition would cover these usages. The dean who thinks that engineers and technicians need only another course in English composition instead of a course in technical writing has forgotten that students are not born with a knowledge of many technical words.

At least seven types of words bother readers and writers of technical English:

1. words demanding a specificity of technical meaning
2. words in the general vocabulary which are often confused with technical words
3. pairs or triads of words with similar meanings but differences in spelling
4. pairs or larger groups of words with similarity in pronunciation but differences in spelling, part of speech, or meaning—including homonyms
5. words in the general vocabulary demanding a specificity of meaning—words which vex trolley riders as well as technicians
6. words confused because of metathesis. [*Metathesis* refers to a transposition of the letters or syllables of a word.]
7. sets of words causing special problems, problems often technical in nature.

The first category is the largest. Naturally, this is the category which has given technical writing its name. For instance, there are *absorb* and *adsorb*, two terms (verbs this time) which have first cousinship of meaning. A blotter will *absorb*, but a glass beaker will *adsorb*. To the trolley rider *acceleration* and *velocity* both mean his bus is moving fast; not so to the technician, who insists that "*acceleration* is calculated as change in *velocity* per unit of time, whereas *velocity* is a measurement of the time spent in traveling a certain distance in a given direction." Or, "*acceleration* is a measure involving time squared, whereas *velocity* is a vector."

To the trolley rider, bugs have *feelers*. Press him and he may remember that certain little creatures have *antennae*, or maybe it is *antennas*. The biological scientist will insist that the creatures have *antennae;* an electronics technician writes about the *antennas* of a microwave installation.

When the trolley rider drives to work on a rainy day, he walks to his automobile along a *cement* walkway or a *concrete* walkway. Perhaps the material in his walkway depends on how hard it is raining or something less direct. Architects and building-construction technicians know that *cement* comes in 94-pound bags. *Concrete* is something that the contractor makes on the job by mixing *cement* with sand, crushed stone, and water.

The fact that American scientists and technicians develop a split personality when they learn basic units accounts for many peculiarities of technical style. Nowadays people practicing engineering and technical professions must learn both British and metric units. Thus *centi* (*centimeter*), *kilo* (*kilocycle, kilogram, kiloton,* etc.), *mega* (*megacycle, megaton*), and *milli* (*milliamperes, millimeter*) add bulk to the technical style. Many industrial concerns (Eastman Kodak Company, for one) are now labeling products in both systems; perhaps one day Johnny will learn to read and write in the vastly more convenient metric system.

The units needed in calculating the application of energy embrace a squad of terms which the trolley rider considers synonyms. To start with, there is *energy*, which comes in two kinds of packages: kinetic and potential, and which is equated to mass (more about this in a moment) times a constant. *Work* is something else. *Power* and *torque* the layman has heard, but he probably considers that *torque* is just a harder way to spell *power*. Or perhaps *torque* is used because it looks more appealing in Detroit's ads. Not so, says the technician, for *torque* means *force* (another one) times distance. *Power* means *work* per unit of time. Whatever the trolley rider may think, *force* and *pressure* are not synonyms; otherwise, no one could lift an automobile with his hydraulic jack.

To a layman, *mass* and *weight* may seem interchangeable, unless he is on a reducing diet—in which case he always "loses *weight*." To the lab technician or physicist, *weight* varies with the location at which he makes the measurement. *Mass* is a dependable quantity. The *mass* of a bucket, no—make it a liter, of water will be the same on Chesapeake Bay Ferry, on the top of Mount Everest, and on the planet Uranus. The *weight*, however, depends on the attraction of the celestial body on which the observer takes the measurement. Fortunately, there is yet no urgency to weigh a liter of water on Uranus; in fact, for many practical purposes, *mass* and *weight* are interchangeable.

And finally, in this class are those two fraternal twins *flammable* and *inflammable*. The prefix *in*, as all know, so often is the linguistic equivalent of a minus sign: in (−) plus efficient (+) equals inefficient (−). But butane, methane, and many other hydrocarbons are both *flammable* (+) and *inflammable* (+); that is, a bystander should go elsewhere to light his cigarette. Fearful of the consequences of combining ignorance of combustion with knowledge of language, safety engineers are now urging that *flammable* be used exclusively. This change comes slowly, for the owner might wait until his propane truck needs a new coat of paint.

A few words in the common vocabulary cause confusion when placed alongside technical words. *Capacity* and *rating* would certainly rank as useful words in the lay vocabulary, and the distinction may not be clear. Yet a motor has a *rating* which is lower than its *capacity*. For that matter, in electrical work *capacity* (or *capacitance*) has a highly specialized meaning. *Complimentary*, the common word, might seem to be the identical twin—with a dash of misspelling—of *complementary;* but *complementary* in mathematics refers to related angles. And *integration* for the social scientist means one thing but for the mathematician quite another.

Like the common vocabulary technical writing has twins, triplets, or even quadruplets of confusion. For example, certain words have similar meanings but differences in spelling or punctuation or both. *Aid* and *aide* are closely related; so, often, are *adapt* and *adopt*. And the triplets of confusion *accent*, *ascent*, and *assent* appear in reports as do *decent*, *dissent*, and *descent*.

Some twins or triplets have similar pronunciation and meaning but differences in spelling or part of speech as most often used: *ascent* and *ascend; advice* and *advise; material* and *materiel;* and *vertex* and *vortex*. *Parameter* and *perimeter* almost earn a place in this category.

Trolley riders, engineers, scientists, and technicians—all may have to reach for the dictionary to *differentiate* (the trolley rider's and not the mathematician's term here) good old *principal* and *principle* or *affect* and *effect*. The second word in each pair appears often in technical writing, as in *Archimedes' Principle* and the *Doppler Effect*.

Sometimes words perplex technicians and laymen too because of an apparent metathesis. These include *casual* and *causal; bare* and *bear; perform* and *preform; stake* and *steak; break* and *brake; great* and *grate;* and *discreet* and *discrete.* With some "twins" the addition or deletion of a letter makes all the difference. Builders use *lath,* whereas machinists use a *lathe;* wire may be specified in *mils* to be installed in newly constructed *mills.* Other confusions result from *ordinance* and *ordnance; dyeing* and *dying; envelop* and *envelope;* and the college student's dilemma of *moral* and *morale.*

Finally (not *finely,* as in *finely divided particles*), a special class of words haunts the engineering writer. The comparison of adjectives makes some sort of sense in English. But in technical English some oft-used words have no logical comparative or superlative degrees. For example, angle A is 89°59′59″, and angle B is 89°59′58″. Is angle A *squarer* than angle B? Not really, for neither one is square within the tolerances of many measuring instruments. Similar words for which logical comparisons do not exist might be *complete, cylindrical, cubic, hexagonal, perfect, perpendicular, rectangular, saturated, true,* and *unique.* Use of the phrase "more nearly" before the positive degree is technically sound, but carpenters are not accustomed to talking about one board being "*more nearly square*" than another.

Technical writing requires, of course, more than skill in using words. The technical writer must know his subject, be able to record data and manipulate formulas, and have skill in constructing graphs. However, technical writing seems here to stay as one of the subdisciplines of language study.

W. EARL BRITTON

What Is Technical Writing? A Redefinition

The definitions of technical writing given by previous writers are examined, and a redefinition is formulated based on the primary characteristic of technical and scientific writing to endeavor to convey just one meaning. W. Earl Britton is in the Department of Humanities, College of Engineering, University of Michigan.

Although the dean of an engineering college once denied the very existence of technical writing, many of us are confident of its reality. But we are not sure that we can convince others of its uniqueness. This uncertainty deepens when we observe the variety of activities incorporated under this label, as well as those that barely elude its scope. Our schools do little to clarify the situation with such course titles as technical writing, engineering writing, engineering English, scientific English, scientific communications, and report writing. Nor do the national societies help with their emphasis upon medical writing, biological writing, science writing, and business English. Applying the general term *technical writing* to a field of such diversified activities is convenient but misleading, yet this is the current practice. In view of the confusion, there is little wonder that a teacher in this field should often be asked, even by colleagues, "What is this technical writing you teach, and how does it differ from any other?"

In addition to satisfying this query, a truly helpful definition should go much further and illuminate the tasks of both the teachers and authors of technical writing. This requirement has been fulfilled in varying degrees by a number of definitions already advanced, the most significant of which form four categories.

Technical writing is most commonly defined by its subject matter. Blickle and Passe say:

> Any attempt . . . to define technical writing is complicated by the recognition that exposition is often creative. Because technical writing often employs some of the devices of imaginative writing, a broad definition is necessary. Defined broadly, technical writing is that writing which deals with subject matter in science, engineering, and business.[1]

Mills and Walter likewise note that technical writing is "concerned with technical subject matter," but admit the difficulty of saying precisely what a technical subject is. For their own purpose in writing a textbook, they call a technical subject one that falls within science and engineering. They elaborate their view by adding four large characteristics of the form: namely, its concern with scientific and technical matters, its use of a scientific vocabulary and conventional report forms, its commitment to objectivity and accuracy, and the complexity of its task, involving descriptions, classifications, and even more intricate problems.[2]

The second approach is linguistic, as illustrated in an article by Robert Hays, who, admitting the existence of technical writing without actually defining it, remarks upon its conservativeness, its Teutonic subject-verb-object word order, and the fact that it shares with other forms of writing the "common" English vocabulary. However, he cites two fundamental differences between technical and other prose. The psychological difference is the writer's "attitude of utter seriousness" toward his subject, and his dedication to facts and strict objectivity. But the greater difference, at least for "teachers and students of technical writing, is linguistic," in that technical style demands a "specialized vocabulary, especially in its adjectives and nouns."[3]

The third definition concentrates on the type of thought process involved. This approach underlies some of the research being directed by A. J. Kirkman, of the Welsh College of Advanced Technology in Cardiff, who has been investigating the causes of unsatisfactory scientific and technical writing. His group is examining in particular the suggestion that a distinction exists between ways of thinking and writing about literary and scientific subjects. The theory postulates two types of thinking, each with its own mode of expression. Associative thought belongs to history, literature, and the arts. Statements are linked together by connectives like *then* and *rather*, indicating chronological, spatial, or emotional relationships. Sequential thought belongs to mathematics and science. Statements are connected by words like *because* and *therefore*, revealing a tightly logical sequence. Professor Kirkman suggests that the weakness of much scientific writing results from forcing upon scientific material the mode of expression appropriate to the arts. He adds:

> The important distinction is that sequential contexts call for comparatively inflexible lines of thought and rigid, impersonal forms of expression, whereas associative contexts permit random and diverse patterns of thought which can be variously expressed.[4]

Finally, technical writing is sometimes defined by its purpose. This approach rests upon the familiar differentiation between imaginative and expository prose, between DeQuincey's literature of power and literature of knowledge. Brooks and Warren find the primary advantage of the scientific statement to be that of "absolute precision." They contend that literature in general also represents a "specialization of language for the purpose of precision" but add that it "aims at treating kinds of material different from those of science," particularly attitudes, feelings, and interpretations.[5]

Reginald Kapp pursues a similar line by dividing writing into imaginative and functional literature. Imaginative literature involves personal response and is evocative; functional literature concerns the outer world that all can see. Functional English, he says, presents "all kinds of facts, of inferences, arguments, ideas, lines of reasoning. Their essential feature is that they are new to the person addressed." If imaginative literature attempts to control men's souls, functional English should control their minds. As he writes, the technical and scientific author "confers on the words the power to make those who read think as he wills it."[6]

All of these approaches are significant and useful. Kirkman's suggestions are certainly intriguing, but I find Kapp's classification particularly helpful and want to extend it slightly.

I should like to propose that the primary, though certainly not the sole, characteristic of technical and scientific writing lies in the effort of the author to convey one meaning and only one meaning in what he says. That one meaning must be sharp, clear, precise. And the reader must be given no choice of meanings; he must not be allowed to interpret a passage in any way but that intended by the writer. Insofar as the reader may derive more than one meaning from a passage, technical writing is bad; insofar as he can derive only one meaning from the writing, it is good.

Imaginative writing—and I choose it because it offers the sharpest contrast—can be just the opposite. There is no necessity that a poem or play convey identical meanings to all readers, although it may. Nor need a poem or play have multiple meanings. The fact remains, nevertheless, that a work of literature may mean different things to different readers, even at different times. Flaubert's *Madame Bovary* has been interpreted by some as an attack on romanticism, and in just the opposite way by others who read it as an attack on realism. Yet no one seems to think the less of the novel. Makers of the recent film of *Tom Jones* saw in the novel a bedroom farce, whereas serious students of Fielding have always regarded it as an effort to render goodness attractive. Varied interpretations of a work of literature may add to its universality, whereas more than one interpretation of a piece of scientific and technical writing would render it useless.

When we enter the world of pure symbol, the difference between the two kinds of communication—scientific and aesthetic—becomes more pronounced. Technical and scientific writing can be likened to a bugle call, imaginative literature to a symphony. The bugle call conveys a precise message: get up, come to mess, retire. And all for whom it is blown derive identical meanings. It can mean only what was intended. But a symphony, whatever the intention of the composer, will mean different things to different listeners, at different times, and especially as directed by different conductors. A precise meaning is essential and indispensable in a bugle call; it is not necessarily even desirable in a symphony.

The analogy can be extended. Even though the bugle call is a precise communication, it can be sounded in a variety of styles. An able musician can play taps with such feeling as to induce tears, and it is conceivable that a magician might blow reveille so as to awaken us in a spirit of gladness. The fact that scientific writing is designed to convey precisely and economically a single meaning does not require that its style be flat and drab. Even objectivity and detachment can be made attractive.

Because technical writing endeavors to convey just one meaning, its success, unlike that of imaginative literature, is measureable. As far as I am aware, there is no means of determining precisely the effects of a poem or a symphony; but scientific analyses and descriptions, instructions, and accounts of investigations quickly reveal any communication faults by the inability of the reader to comprehend and carry on.

Objection may be raised to this distinction between the two kinds of writing because it makes for such large and broad divisions. This I readily admit, at the same time that I hold this feature to be a decided advantage, in that it removes the difficulty that usually arises when technical writing is defined by its subject matter.

Emphasis upon engineering subject matter in technical writing, for example, has implied that engineering has a monopoly on the form, and that a PhD dissertation in linguistics or even certain kinds of literary criticism and a study of federal economic policy are other kinds of writing. When all such endeavors that convey single meanings are grouped under the label technical and scientific writing, or some other term, for that matter, then division of these into subject areas, instead of creating confusion, becomes meaningful. Some subjects will be far more technological than others, ranging from dietetics to nuclear fission, and in some instances being related to science only by method of approach; some subjects will offer more linguistic difficulty than others; some will require a tighter, more sequential mode of thinking; but all will have in common the essential effort to limit the reader to one interpretation.

It seems to me that this view not only illuminates the nature of technical writing but also emphasizes the kind of training required of our schools. Unfortunately, few educational institutions are meeting the needs in this field. Professor Kirkman mentions the failure of the traditional teachers to provide enough practice in writing on practical subjects. Professor Kapp has insisted that the conventional instruction in formal English courses does not equip a man to teach or practice scientific and technical writing. The Shakespearian scholar, G. B. Harrison, commenting upon his formal writing courses in England, says:

> The most effective elementary training I ever received was not from masters at school but in composing daily orders and instructions as staff captain in charge of the administration of seventy-two miscellaneous military units. It is far easier to discuss Hamlet's complexes than to write orders which ensure that five working parties from five different units arrive at the right place at the right time equipped with proper tools for the job. *One soon learns that the most seemingly simple statement can bear two meanings* and that when instructions are misunderstood the fault usually lies with the wording of the original order.[7] [My italics]

But our strictures should not be confined to the English teachers. All of us in education must share the responsibility for this condition. In fact, I believe that in all too many instances, at least in college, the student writes the wrong thing, for the wrong reason, to the wrong person, who evaluates it on the wrong basis. That is, he writes about a subject he is not thoroughly informed upon, in order to exhibit his knowledge rather than explain something the reader does not understand, and he writes to a professor who already knows more than he does about the matter and who evaluates the paper, not in terms of what he has derived, but in terms of what he thinks the writer knows. In every respect, this is the converse of what happens in professional life, where the writer is the authority; he writes to transmit new or unfamiliar information to someone who does not know but needs to, and who evaluates the paper in terms of what he derives and understands.

B. C. Brookes takes a similar position when he suggests that English teachers concerned with science students should ask them occasionally to explain aspects of their work which they know well so that the teacher who is unacquainted with the material will understand it. Such an assignment not only is a real exercise in composition but also taxes the imagination of the student in devising illuminating analogies for effective communication. The teacher's theme should be: "If your paper is not plain and logical to me, then it is not good *science.*"[8]

Both Harrison and Brookes recommend the kinds of exercises that are often viewed skeptically at the college level. This is a regrettable attitude, especially since it usually derives from unfamiliarity with the nature and need of such work and from unawareness of its difficulty and challenge. Teachers oriented primarily toward literature see little of interest in this field, but those who enjoy composition—especially its communicative aspect—can find considerable satisfaction here. Of one thing they can always be sure: deep gratitude from those they help.

NOTES

1. *Readings for Technical Writers*, ed. Margaret D. Blickle and Martha E. Passe (New York, 1963), p. 3.
2. Gordon H. Mills and John A. Walter, *Technical Writing* (New York, 1954), pp. 3–5.
3. Robert Hays, "What Is Technical Writing?" *Word Study*, April, 1961, p. 2.
4. A. J. Kirkman, "The Communication of Technical Thought," *The Chartered Mechanical Engineer*, December, 1963, p. [2].
5. Cleanth Brooks and Robert Penn Warren, *Understanding Poetry*, 3rd ed. (New York, 1960), pp. 4–5.
6. Reginald O. Kapp, *The Presentation of Technical Information* (New York, 1957), chaps. I–II.
7. G. B. Harrison, *Profession of English* (New York, 1962), p. 149.
8. B. C. Brookes, "The Teaching of English to Scientists and Engineers," *The Teaching of English*, Studies in Communication 3 (London, 1959), pp. 146–7.

EDMUND P. DANDRIDGE, JR.

Notes toward a Definition of Technical Writing

A project which deals with the stylistics of technical writing is discussed. The conclusions reached shed some light on the difference between technical and nontechnical writing. Edmund P. Dandridge, Jr., is in the Department of English, North Carolina State University at Raleigh.

Introduction

Most definitions of technical writing say little about stylistic features which distinguish that kind of writing from nontechnical, nonfiction writing. I have long entertained a notion that there is a difference—that good technical writing is, on the whole, stylistically simpler than good nontechnical writing.

To test this assumption, I undertook a statistical analysis of ten pieces of writing of each type. Samples of 50 consecutive sentences from each article were examined to determine such matters as sentence length in words, frequency of sentence occurrence by grammatical type, paragraph length and frequency, and similar stylistic features that might lead to a supportable generalization. The pieces

Table 1. Total Words—50 Sentences

T		NT
948	A #1	945
965	A #2	1,024
1,085	A #3	1,027
1,133	A #4	1,205
1,176	A #5	1,243
1,189	A #6	1,314
1,251	A #7	1,340
1,424	A #8	1,367
1,513	A #9	1,621
1,581	A #10	1,732
12,265		12,818

Table 2. Average Sentence Length—Words

T		NT
18.9	A #1	18.9
19.3	A #2	20.5
21.7	A #3	20.9
22.6	A #4	24.1
23.5	A #5	24.8
23.7	A #6	26.3
25.0	A #7	26.8
28.4	A #8	27.3
30.2	A #9	32.4
31.6	A #10	36.6

Table 3. Longest, Shortest, and Average Sentence Length—Words

T				NT		
L	S	AV		L	S	AV
37	8	19.3	A #1	42	8	20.9
38	11	23.5	A #2	44	9	24.8
44	9	21.7	A #3	47	10	18.9
46	4	22.6	A #4	54	11	20.5
47	6	23.7	A #5	54	12	24.1
49	6	18.9	A #6	55	13	26.3
49	7	25.0	A #7	72	13	36.6
57	9	28.4	A #8	75	14	26.8
63	10	30.2	A #9	76	16	27.3
65	12	31.6	A #10	79	16	32.4

to be examined were chosen—as objectively as possible—from a broad range of technical and nontechnical sources. The technical articles ranged from full-blown formal reports to articles from professional and trade publications such as *IBM Systems Journal*, *Westinghouse Engineer*, and *Computers and Automation*. The nontechnical articles came from current periodicals of the kind I thought might be found on coffee tables in homes of people with educational backgrounds similar to those of engineers and scientists. The selection ranged from such publications as *Saturday Review*, *The Atlantic Monthly*, *AAUP Journal*, and *Smithsonian* to *Newsweek* (a lengthy feature article on education), *Look*, and *Southern Living*. The 50-sentence samples were taken from roughly the middle of each article, on the ground that the writing there might be more indicative of each type than if the material came from introductory or concluding sections.

Analysis of the accumulated data does not support my hypothesis as strongly as I had hoped. However, when a number of stylistic matters are examined one by one and are then more or less lumped together, the assumption seems to be adequately supported.

Analysis of the Data

In the material to be discussed, the letters T and NT signify the technical and nontechnical articles. The symbol A# means article number and is used simply as a means of explaining the data, rather than as identifying a specific article. For example, A#3 in three different tables would probably refer to three different articles, rather than to a single article.

Let us look first at the total number of words in each of the 20 samples (Table 1). The articles are arranged from top to bottom of the columns by increasing numbers of words. Only at T A#3 and A#8 was the T article longer than its NT counterpart. The total number of words in the NT column was 553 greater than in the T column.

If we examine sentence length (Table 2), we see that in all except three instances the NT sentences were the longer, albeit not by very much. If we set 24 words as a good average length, we note that six of the T writers stayed below that average, while only three of the NT's did so.

A look at Table 3 reveals something else about sentence length. Here, consistently down the T column, the longest sentences were

Table 4. Number of Paragraphs (Column A) Compared with Average Number of Sentences per Paragraph (Column B)

T			NT	
A	B		A	B
6	8.8	A#1	8	6.1
11	4.7	A#2	9	5.8
13	3.8	A#3	10	5.0
14	3.7	A#4	11	4.5
14	3.9	A#5	12	4.3
14	3.9	A#6	13	3.8
15	3.5	A#7	13	3.9
16	3.3	A#8	14	3.8
17	3.1	A#9	16	3.2
17	3.2	A#10	16	3.2
137			122	

Table 5. Sentences per Paragraph

T		NT
3.1	A#1	3.2
3.2	A#2	3.2
3.3	A#3	3.8
3.5	A#4	3.8
3.7	A#5	3.9
3.8	A#6	4.3
3.9	A#7	4.5
3.9	A#8	5.0
4.7	A#9	5.8
8.8	A#10	6.1

Table 6. Average Words per Paragraph

T		NT
63.8	A#1	73.4
67.7	A#2	85.8
74.2	A#3	85.4
78.2	A#4	94.5
83.8	A#5	95.6
84.9	A#6	100.4
105.4	A#7	101.1
106.9	A#8	128.0
108.1	A#9	147.4
188.8	A#10	192.4

shorter than the longest NT sentences. Oddly, nine of the shortest T sentences were longer than the shortest NT. This may be the result of NT writers consciously including short sentences now and again for variety—something that T writers are less inclined to do.

If we turn to paragraphing, we see in Table 4 that the T writers used 15 more paragraphs than did the NT's, 137 as opposed to 122. (This difference is represented graphically in Figure 1.) Of course, in both kinds of writing, the number of sentences per paragraph decreased as the number of paragraphs increased. (See Table 5.) If, however, the numbers of sentences per paragraph are isolated in columns arranged from fewest to most, a glance shows that in eight instances the T paragraphs contained fewer sentences than the NT paragraphs. One further point can be made about paragraphs: Table 6 reveals that, except for A#7, the T paragraphs contained fewer words than the others.

Finally, Table 7 provides some information about frequency of sentences by grammatical type—Simple (S), Complex (Cx), Compound (Cp), Compound/Complex (CpCx). The articles are ordered at the left on the basis of increasing numbers of simple sentences. The column total shows that the T writers used more simple sentences than their

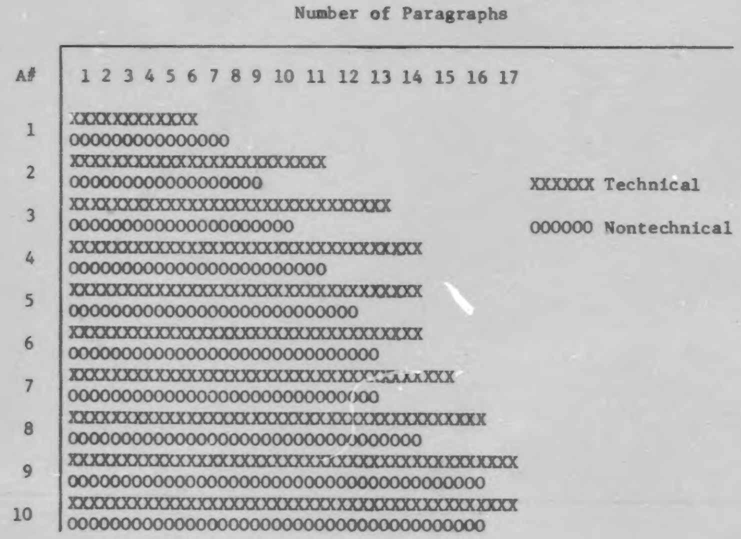

Figure 1. Number of paragraphs per 50 sentences.

NT counterparts. The number of complex sentences is close to the same for each group. But the T writers wrote fewer of the two more sophisticated types—compound and compound/complex.

Table 7. Frequency by Sentence Types

	S		Cx		CP		CpCx	
A#	T	NT	T	NT	T	NT	T	NT
1	18	7	21	31	7	7	4	5
2	19	19	16	23	6	2	9	6
3	20	20	27	26	2	4	1	0
4	21	22	25	19	2	3	2	6
5	25	23	23	17	2	6	0	4
6	26	25	23	17	1	7	0	1
7	28	25	13	12	5	10	4	3
8	29	27	15	18	5	3	1	2
9	31	32	17	15	2	2	0	1
10	40	43	7	5	3	1	0	0
	257	243	187	183	35	45	21	28

Conclusions

If the findings from the data are now pulled together, the following characteristics can be attributed to the technical samples:

1. Fewer words in total sample.
2. Fewer words in 8 of 10 articles.
3. Longest sentences shorter than in NT articles.
4. More paragraphs in 9 of 10 articles.
5. Fewer sentences per paragraph in 9 of 10 articles.
6. Fewer average words per paragraph.
7. Greater number of simple sentences.
8. Fewer compound and compound/complex sentences.

On the basis of these characteristics, the assumption that technical writing is, generally speaking, less complex stylistically—and therefore probably more direct—than nontechnical, nonfiction material seems to be tenable. Undoubtedly, a much larger sample from both kinds of writing would substantiate the findings here more conclusively.

2

Teaching Technical Writing

FRED H. MACINTOSH

Teaching Writing for the World's Work

Technical writing is as varied, complex, and challenging to both teacher and student as are imaginative writing and literary criticism, states Fred H. MacIntosh, Director of Advanced Composition, Department of English, University of North Carolina, Chapel Hill. This previously unpublished paper was read at the eighth annual Southeastern Regional Conference on English in the Two-Year College, Jacksonville, Florida, February 16, 1973.

For most holders of advanced degrees in literature—that's what they really are in most English departments—the prospect of teaching technical, scientific, business, medical, or any career-oriented writing course is likely to produce disdain, defensiveness, uncertainty, escapism, revulsion, or outright panic. No wonder—for most English teachers have shunned science, taken reading courses rather than writing courses, and often never had a college composition course. Or if they had one within the past ten years, it is likely to have emphasized personal writing, subjective writing, or writing about literature—and even their writing in literature courses emphasized content more than composition. As teachers they have avoided teaching composition wherever possible, and usually know very little of the worlds of business, industry, technology, government, health, or defense. In general, they are largely innocents in the sorts of writing so vital to the world's work.

Before you shout me down as a Judas betraying our sacred tradition of literary studies as the summum bonum in an otherwise crass world, let me confess that the previous paragraph is a self-portrait—not of the artist as a young man, but of a blind and arrogant professor. Several years ago, as a professor of English at Clemson with a doctorate in eighteenth-century literature from Duke, I was smugly celebrating my escape from freshman composition and my freedom to teach nothing but literature—until circumstance pushed me into teaching engineering writing, to which I had been snidely supercilious and loudly scornful. I protested that such work was for clods, certainly not for a Ph.D. capable of *literary criticism* and *research*! But my dean, a wise man, firmly told me that the experience would be good for me, and I went sulking off to lick my vanity. Since I had been schooled in the older tradition that the really professional teacher does to the best of his ability whatever courses he is assigned, and that to do his own thing at public expense and deprivation of students is juvenile and parasitic, I calmed down and went to work to learn enough to teach the course. Gradually, three points forced themselves upon me: (1) writing in their own fields, several students I had put down as dullards in freshman English turned out to be excellent writers for their own purposes; (2) the progress shown by the whole class of juniors and seniors pleased them and me; (3) I was heartened by the help offered by the engineering faculty when they saw how much their students' writing was improving their engineering reports and quizzes. In short, I found the course highly valuable, I learned to write more directly, and the teaching was as challenging as literature teaching. Good luck then brought me summer work as reports and proposal writer and editor in a large aerospace complex; that work led to my being recommended for my present position as director of the University of North Carolina's advanced composition program (advanced expository writing, business writing, and scientific writing); and for fourteen years I have thoroughly enjoyed and profited from summer and vacation work as writer, editor, proposals consultant, and teacher of mid-management writing courses in industry, government, research centers, and military bases. Personally, the work has been immensely rewarding, and professionally, it has saved me from parochialism.

Hence I come to you now as missionary, and I urge the charge of stewardship. My purpose is to convince you that perhaps disdain for purely practical writing may arise from lack of knowledge, that perhaps uncertainties about what technical writing really is and how it might be taught may be resolved, that perhaps fears of attempting it need modification, and, especially, that career-oriented writing is every whit as complex, sophisticated, challenging, and rewarding to both student and teacher as are imaginative writing, purely subjective personal writing, or literary exposition or criticism. What's more, career-oriented writing is more highly prized by the society which supports us—in fact, so highly prized that if we are to survive the increasing attacks upon our integrity and credibility, we must concern ourselves, first and foremost, beyond all our other legitimate concerns, with the world's first expectation of us: producing in our students genuine competence in the sort of spoken and written language required for the world's work.

Suppose I begin my missionary task by trying to give the larger view of what constitutes the writing that does the world's work. Since too frequently the uninformed think of business and technical writing as cranked-out routine within a few rigid formats, probably the most fruitful approach is to look first at the many purposes of such writing. My experience—within fourteen industries, sixty-odd major corporations, three scientific research and development centers, all three branches of the armed services, and Washington headquarters of three major departments of government—indicates that the following are the most frequent purposes of writing in the world of work: (1) to present factual information clearly and concisely; (2) to describe items, equipment, systems, processes, procedures; (3) to explain ideas, concepts, principles, laws; (4) to analyze data, problems, situations, relationships; (5) to interpret or evaluate; (6) to make a sound, factual, logical case for a viewpoint; (7) to adapt material written for any of these purposes to different audiences and circumstances; (8) to plan and write for oral presentation; (9) to write for the signature of others.

These many purposes of business and technical writing are served in varying combinations in the following forms and formats: letters, short memoranda, longer memoranda, short reports, long formal reports, information sheets, prospectuses, abstracts, digests, summaries, analyses, studies, profiles, manuals, bulletins, highlights, directives, guidelines, job descriptions, performance evaluations, briefs, position statements, public information releases, proposals, feasibility studies, progress reports, audit reports, fiscal reports, scripts for large-audience oral and media presentations, discussion guides for small-conference groups, and so forth.

This lengthy recital of purposes and forms of career-oriented writing, already too large for one course, should explain my earlier statement that the writing that does the world's work is every whit as complex, difficult, varied, and challenging to both teacher and student as are imaginative writing or literary criticism. Perhaps the point becomes even more self-evident when we look at the following problems and skills involved in such writing. They are: absolute clarity at first, rapid reading; shrewd consideration of audience and situation; sensitive awareness of how, where, and by whom the writing will be used; appraisal of the patterns of information flow within the receiving organizations; knowledge of and skill with many rhetorical strategies; expertise in choosing among these strategies; command of many organizational patterns; deciding upon, and achieving, the most effective tone for audience and purpose; pace and density; level of vocabulary; semantic considerations; sensitivity to audience receptivity factors; many ways to make organization evident to readers; the nature of evidence and proof; logic, appropriate format for purpose, company internal organization, information flow, communication channels, nature of distribution list; planning to present data graphically rather than verbally; selecting the most effective sort of graphic to support text; possible adaptation to or use for data processing, programming, information storage, or information retrieval; substantiation of generalities; unifying paragraphs and groups of paragraphs; making key sentences immediately recognizable as such; making the larger interrelationships and continuity *immediately evident* to a rapid reader; effective structure for key sentences; clarity of sentences; conciseness of sentences; precision of wording; variety of sentence structures; grammatical decency; punctuation and mechanics; spelling; and proofreading.

Having read these lengthy lists of the purposes, forms, planning problems, writing skills, and associated knowledge necessary for effective technical or business writing, you should be willing to accept at least one point of this discussion: namely, that writing and/or teaching this writing that does the world's work is surely as complex, difficult, and intellectually demanding as imaginative writing or writing about literature. Of course you can still react as the subject of Pope's telling thrust: "A woman convinced against her will,/ Remains of the same opinion still." Or you can adopt the attitude of the listener in a North Carolina teachers' group. One lady who liked what I was saying jabbed an elbow into her neighbor, apparently an antagonist in her school, and said in vehement approbation, "Do you hear what he said?" To which the neighbor replied, with equal vehemence, "I hear, but I'm doing my best not to listen!"

If you are now willing to take career-oriented writing seriously, some changes of attitude may be necessary. Probably the fundamental step towards preparing to teach these courses is a basic change of attitude, a willingness to cut the umbilical tether back to the purely literary studies of most graduate English programs, and instead walk down main street with open minds, to hear the world's ideas of its language needs, not the ideas of the English departments (nor, perhaps, of the education schools or the psychologists). Many of you have already made that step or are inclining towards it, for in the two-year colleges teachers must work closer to reality than we in the four-year college and universities, where too often good and learned but narrowly experienced people seem to take perverse pride in forswearing the world. The origin of that attitude was medieval; and it is still medieval. Equally monkish is a widespread attitude among young, bright, idealistic English majors that serious concern for either frankly utilitarian writing or rhetoric and communicative effectiveness somehow sullies their precious purity and flaunted integrity. (Parenthetically, I'm tempted to call this immaculate conception of the teacher's task either professional virginity or professional frigidity.) To teach career-oriented writing with commitment one must choose among Wordsworth's "The world is too much with us," Byron's "The world is a bundle of hay," Robert Browning's "This world means, and it means intensely," and Edna St. Vincent Millay's "O world, I cannot hold thee close enough!" If Chaucer is so tellingly shrewd because he was first a man of business, if Shakespeare frankly wrote for bread, if Milton could lay aside long-cherished plans for a great epic to put his pen to the business of the commonwealth, if Swift and Johnson are so powerful because they so well knew man in the world of affairs, if Matthew Arnold urges us to see life steadily and see it whole, and especially when we urge involvement in the causes dear to us—how can we then scorn the writing that does the world's work and often leads to its most momentous decisions? I like Jack Kennedy's tribute to Churchill: "He mobilized the English language and took it to war."

A second attitudinal change perhaps necessary to teach utilitarian writing is a willingness to reconsider the alleged values of writing about literature; of writing to find oneself; of reading imaginative works as a road to workaday expository prose; of writing for and to oneself in notebooks; of provocative reading or discussion in order to stimulate the student or to give him something to say; of freeing the student from blocks, hang-ups, or prescriptive or proscriptive teaching; and, especially, of the need "to express himself." Useful as some of these may be in other writing courses, they are not realistic for the career-oriented writing courses. For there the student has plenty to write about—the content of his major subject or his work. Nor can he in the world wait for the mood and time and place and encouragement and appreciation and a smiling environment to pour forth his uniqueness; for in the world of work he writes on demand—usually somebody else's demand, someone who can promote or fire, who is concerned only with results, and who in turn must meet deadlines imposed by others. Nor is the writer in business or science primarily concerned with expressing himself; his concern must be for effectively communicating to others what they have a need to know; and the virtues of most of such writing are clarity, conciseness, precision, and logic—not qualities evident in devotees of orgasmic rhetoric and ejaculatory style. In brief, and perhaps too simplistically, most of the approaches listed in the early part of this paragraph encourage the student to look inward and express as truly as possible what he finds there; but business and technical writing most often ask the writer to look outward, to concentrate upon what his reader needs or wants, and how the writer can most quickly and clearly communicate it to him in a form he can use for his purposes with his associates. Most business and technical writing is as totally functional as a wrench: if it doesn't do the required job, it's a failure.

Given today's climate of educational theory, a third matter of basic attitude may be more difficult to achieve: that is, honesty with ourselves, our students, their employers, and the public in facing the facts of students' achievements at the end of the course. For the competitive world of work for which our passing grade says our student is ready judges him by performance alone, and judges us by his performance. It's bad enough for us to have to admit failure when the student has tried and we have tried; but it's deception—cruel deception—to say to student, parents, and community that a student can perform adequately when we really know that he cannot do so. Here, I fear, is the crux: regardless of the difficulties under which we labor, regardless of administrative and community pressure to pass, regardless of the psychologists' and educationists' and sociologists' laudable insistence that we take the student where he is and teach accordingly—regardless of all these, the world expects satisfactory performance in work situations, and a person's ability or inability to speak or write adequately in his work situations is inescapably evident. In simpler language, if students do not achieve, we should not say by our grades that they do, for the world will quickly find us out.

In this context, for those who teach disadvantaged students of any background, if we hope to help them towards upward mobility, we should remember that almost any leadership or supervisory function means even more need for effective communication within increasingly complex situations. The best way I know to close the world's upward doors to a student is to say by transcript that he is competent in the mathematics and language required in a work situation when his achievement with us shows that he is not. For us to do so is to demolish the integrity of our teaching and the credibility of our profession.

If you are now convinced of the worthwhileness of teaching career-oriented writing courses, and if you have made or can make the attitudinal changes, there remain the obvious practicalities. Your first logical question may be: how can I teach students to write about things of which I know very little? The first obvious answer is: read the texts, materials, manuals, and instruction sheets your students use in their career courses. Most of these materials are simple and lend themselves to fast reading for general information. Second, talk to the instructors of the courses; find out from them what they are teaching; and, if necessary, ask for further materials. But make clear to your students that content is their responsibility, and that your concern is clarity of presentation—that is, exactness of words, exactness of phrases, clarity of sentences, obvious unity and obvious coherence of paragraphs, obvious continuity, obvious linkage of sections, obvious clarity of larger interrelationships, and introductions and endings which help the reader to anticipate what is coming and help him at the end to draw together the major points. For more complex writing your concerns will also extend to strategies, tone, pace, and density. These are the central things you are doing in dealing with writing of almost any sort, and you will not find it difficult to transfer these concerns to technical matter, especially if you grade papers in conference and can ask the student questions about his content. As for technical vocabulary, it will be relatively limited: usually even the most technical writing is approximately ninety-five percent general language, which you know better than the student.

Then there is a second question: how can I build a course outline to cover the actual needs of the students, especially when the course and students are too limited to deal with all the complexity discussed in the earlier description of the range and sophistication of business and technical writing? The best way is to pool your knowledge of the purposes of writing and the technical instructor's knowledge of what language situations his students will face in the classroom and on the job. Probably you should expand his notions somewhat by talking to employers, for frequently the vocationally oriented teacher has to stay so close to the basics that he is not always aware of what communication problems may face the student five years out, after he has risen to wider responsibilities. (Technological industry is littered with unpromotable people of excellent technical skills but too limited language and math to progress beyond basic work.) Then decide which of the purposes of writing earlier stated seem most necessary for the students, and ask the technical instructors to frame a series of assignments, going from simple to complex, which will make their students confront the problems involved in each of these purposes. As far as possible, students in different fields should be planned for and taught separately. Three obvious groupings are trades, business, and health.

A third practical question concerns the course organization and progressions within it. My experience inclines me to plunge the student into the most frequent and simplest communication purpose, simply furnishing information, and thereafter lead him through increasingly longer and more complex problems. Although his writing will be full of basic errors in the beginning, these will gradually decline as he writes more and more and as you occasionally stop to take a full class period to work on what seems to be a common weakness. But you will kill all interest, and accomplish very little anyhow, if you start the course with a comprehensive review of grammar and usage. The students and their technical instructor rightly want both to get straight into the communication problems that must be faced in work situations. Individual remediation for clarity, conciseness, and organization will produce better results faster, as well as free you from the charge of giving just another high school course. Another approach common to composition courses—starting with the sentence on the premise that the student who can write a good sentence will learn to write a good paper—is also of dubious value here. For these students need first to face the problems of purpose, audience, and organization; they are more important to their effective communication than are the smaller units of words and sentences.

The fourth practical question usually asked concerns the day-by-day time spent on each writing problem. Many experienced people have come to have each paper written by stages within a cumulative cycle of classes. The most common cycle is to first spend a class discussing the problem, suggesting many ways to approach it, and asking the students to come into the next class prepared to name their topic, anticipate its potential difficulties, and tell how they expect to organize their papers. This sort of talk usually triggers new or better ways of writing the paper than the student thought about alone. For the third class students are asked to bring in a tentative draft and asked to read aloud for class comment, or to have the draft duplicated for class comment, or to have the draft circulated for individual evaluation and suggestion by many other members of the class. For the fourth class they are asked to use whatever comments seem valid and to bring in the final copy, which is then evaluated by circulation among all class members. For the fifth class the teacher cancels the formal class meeting and, adding regular conference time to the class hour, schedules students for individual conferences on and grading of the paper, with suggestions for individual work on weak points. Although most teachers will have difficulty finding time for the individual grading, experience convinces me that a ten-minute reading of a paper with the student beside me produces more improvement on the few central points I choose to discuss than a laborious thirty minutes of writing close comment on all the shortcomings of the entire paper. More important, the constructive attitude communicated to the student as you *show* him how to improve creates a rapport difficult to achieve otherwise. Furthermore, he has a chance to ask questions. If you evaluate and suggest rather than grade the papers of the first half of the course, you have a better chance of motivating improvement. Also important to your professionalism is the fact that recorded schedules of conference time enable your department chairman to prove the point that teaching writing takes more time than teaching other subjects. Without that specific record of time spent on papers, his words to administrators often sound only like special pleading.

As for other practical considerations, such as textbooks, if you know nothing about the field, I have an extensive list of the most widely used in both technical and business writing; write me if you want copies. To learn more, join either of two associations, the Society of Technical Writers and Publishers and the American Business Writing Association, both of which have meetings and publish journals. If you wish, write me for addresses. Both are seriously concerned about effective teaching in these fields, and both carry very useful articles. The advanced composition section of SAMLA often includes these courses in its programs, as do the more useful annual program and journal of the College Conference on Composition and Communication, which features an excellent session on technical writing.

But far more useful than any academic approach to the problems of writing for the world's work is personal experience with the worlds of either business, industry, government, or defense, for only that way will you really understand the purposes and uses of language in the world of work. A by-product of such experience will also probably be considerable change in your thinking about other writing and literature courses as well. You need not work as writer or editor or teacher in these worlds, for experience doing almost anything in a major complex enterprise will make you acutely aware of the communication problems faced by everyone in the workaday world where your students will spend their lives.

The other possibility is the obvious one of taking these courses, or the more common, all-purpose course in advanced expository writing at the graduate or undergraduate level which we offer every summer and which is widely offered elsewhere. Also, the seven or eight really experienced people in this area undertake consulting sessions for departments needing help in planning and staffing these courses.

In closing, let me offer a few cautions to chairmen or deans who must assign people to teach these courses. Although I have suggested that most English teachers could make the transition to this teaching, I would assign only experienced people of proved competence in other composition courses; for the average product of English graduate programs is prepared to teach only literature; and bright and willing as the person may be, the first two years of composition teaching will be largely a record of error. Almost no one will be able to confront simultaneously the double program of learning to teach composition—for which he is unprepared—and learning what is important to teach in fields foreign to him. To assign a beginner to these courses is unfair to the teacher, unjust to the technical departments, and almost certain to hurt the departmental reputation in the institution.

Once into these courses, the successful teacher should be used there frequently enough for the courses to profit from his accumulated experience; but the courses should not become the province of only a few specialists; technical writing teachers need the breadth of teaching many courses, and they may feel that they are being denied their fair share of college transfer and literature courses. Also, to give the courses the departmental status they deserve, they should become a generally shared concern, a condition achieved only when most instructors teach them, and especially when most of the best instructors teach them in due course. But one caveat is in order: for these courses, keep out the impulsive, the overly sympathetic, the erratic, the undisciplined, and the professional enthusiasts. They simply won't do the job.

May I close with a both sobering and hopeful reminder. We English teachers have passed the days of wine and roses. We face a world of shrinking support—or perhaps a more searching realism—in which priorities, relevance, and accountability are the watchwords. Gone is the public's willingness to provide for the pursuit of excellence, for we have not produced excellence. Gone are the days of generous corporate support, for our average products enter the world of work lacking basic knowledge and skills, and too many of our brightest seem more interested in wrecking private enterprise than contributing to it. To too much of American society, our products are disappointing. Perhaps a healthy first step towards restoring our credibility in the world is to pick up again, with commitment, the service concept we used to hold, the concept that an English department's first duty is to teach effective use of the language for the world's work. Achievement or nonachievement there is always visible, and our support from the world, I predict, will depend on our achievement there, and only there.

DAVID E. FEAR

Notes on Coping with Heterogeneous Community College Technical Writing Courses

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Five sources from which technical writing teachers can gain technical knowledge in a short time—technical textbooks, instructors of technical courses, introductory lectures in appropriate courses, students in technical and scientific fields, and area employers—are discussed by the author. David E. Fear is in the Department of English, Valencia Community College, Orlando, Florida.

In the past several years, the rapid growth of two-year occupational programs in American community colleges has brought special problems to many English teachers. Conventional M.A. or Ph.D. trained teachers are being asked (and sometimes required) to teach a "thing" called technical writing. Then they are told that technical writing is supposed to help occupational students cope with the everyday writing needs of their chosen professions. These students need practical skills, so the story goes, not work in interpreting and reacting to literature. The beleaguered teacher is reeling by now, but the final blow is still to come. He learns that the students to whom he is supposed to teach these practical, job-related communication skills represent practically every technical profession in the community, including some he is not sure he can even pronounce. Just how does one teach communication skills to a class composed of everyone from police officers and firemen to respiratory therapists and x-ray technicians, with a few aspiring horticulturists and data processors thrown in for good measure? How, for that matter, does even the experienced technical writing instructor cope with such a situation? Obviously, there is no one easy answer.

Several possible solutions are being tried, with varying degrees of success. Some instructors use a case-study approach, with all students writing about the same semi-technical or non-technical subject matter. Others ask the student to use subject matter from his own field of study, but require him to write at a low level of technicality so that the instructor can easily comprehend the content. A third approach is to ask students to write from within their own fields but to require them to write at various levels of technicality, according to the demands of the specific piece of writing assigned.

Although each approach has definite strengths and equally definite weaknesses, no attempt will be made here to analyze all three nor to argue their relative merits. Rather, concentration will be centered on one approach: require students to write from within their individual fields of study and require them to use whatever levels of technicality prove appropriate to specific writing assignments given.

In a course taught this way students will no doubt write some nontechnical assignments easily understandable to the instructor. However, many student papers will discuss at high levels of technicality subjects of which the instructor knows little. He might well have to evaluate nursing notes on the post-operative care of hemorrhoidectomy patients, or complex flow charts detailing the processing of a workmen's compensation claim by a large insurance company. Indeed, evaluating such highly technical materials might seem totally impossible to the typical technical writing teacher who is more at home with John Dryden, Phillip Freneau or Sir Francis Bacon than with electronics or forestry.

Bacon, as a matter of fact, is perhaps the last person who could even hope to know enough about enough different subjects to judge the technical accuracy of any piece of writing that might cross his desk. So, do not even consider trying to learn enough to become a highly technical reader in all of your students' occupational areas.

But, with a bit of perseverance you can learn enough about these areas to effectively evaluate student writing and, more importantly, to help students improve that writing. Begin by assuming that good writing is good writing regardless of the subject. Well-written analyses possess certain common characteristics whether it is an undercover narcotics investigation, an electronic circuit, or a Spenserian stanza that is analyzed. The same can be said about descriptions, narrations and so on.

The precise criteria to use will vary from instructor to instructor and any instructor can readily develop his own if he starts with clarity, conciseness, and reader adaptation. This will no doubt lead into consideration of such items as transition, thesis development, logic, objectivity, verbosity, etc. Such factors can be judged without complete understanding of content. One need not understand the terminology involved in a description of a piece of electronic apparatus to recognize that the description lacks organization or that some portions of the apparatus are described in much more detail than are others.

This is not to claim that no knowledge of subject matter is needed. Such knowledge is certainly useful. But getting enough of it to cope does not require actually learning a discipline. Just as professional technical writer-editors are able to gain in a very short time enough technical knowledge to make effective reports or proposals from the written notes of engineers with years of training and experience, so can the technical writing teacher gain enough technical knowledge in a short time. Here are a few sources of this knowledge:

1. Technical textbooks—get copies of introductory textbooks in your school's occupational programs. If your library does not have them or your bookstore cannot get them for you, check with the instructors of the appropriate courses. Then read the books, paying special attention to terminology, processes, and equipment and material descriptions. The introductory overview given in a good introductory text will enable you to understand a surprising amount of the content of your student's writing.

2. Instructors of technical courses—get to know them. Let them know what you are trying to do in your technical writing courses. They will usually do all they can to help you if they realize that you are really trying to help their students develop better on-the-job skills. They can explain equipment, processes and terminology to you; they might furnish handouts and lecture notes, as well as books; they can make suggestions about the specific writing needs of their field; they might even furnish some samples of writing actually done in the field.

3. Lectures on the subject—sit in on a few introductory lectures in the appropriate introductory courses. You need not take or even audit the entire course. Check with the instructor for the best times to sit in.

4. The students themselves—learn from them as they learn from you. Many students in community college occupational programs are already experienced in their field: Law enforcement officers needing degrees for promotion, LPN's seeking to become RN's, office workers seeking more saleable skills. They can help both you and the less-experienced student with content: they can bring in sample documents they and their superiors have written on the job. One technique that is often useful is to simply ask the student questions about the content of his paper. If you suspect weaknesses in a student paper but are uncertain because you do not really understand the content, try asking a question such as, "This doesn't seem clear; are you sure your intended reader could understand it?" or, "This seems wordy to me; wouldn't it still be understandable if you removed this and this?" Your response will usually be something such as, "By golly, you're right," or, "No, because . . . ."

5. Area employers—get suggestions from them. Contact some of those who employ graduates from your technical programs. As well as letting you know what types of writing your students need, they will often have samples of actual writing done and perhaps even printed materials to help you learn subject matter.

It will still be difficult at first. Time is required in order to utilize even the best sources. And the fifteen contact-hour teaching load of the typical community college instructor keeps him busy enough preparing teaching materials and evaluating papers that he has little time left over to spend learning new material. But if he really wants to do it, he can find some time, and gradually he will begin to understand more and more of the seemingly esoteric reports his students are writing. Before long he might even find himself telling a student nurse to check her data, that the medicine she describes as a stimulant is actually a depressant; or he may find himself explaining to an aspiring young computer programmer that not only has he written an incomprehensible proposal, but that the program described in the proposal would not work anyway.

The method advocated here is obviously not an easy one to use. But if an instructor is convinced, as I am, that the best technical writing course is one which gives students the most practice doing the same types of writing they will do after graduation, he should give it a try. It should prove to be worth the effort.

3

Skills, Needs, and Goals of the Technical Writing Student

JUANITA WILLIAMS DUDLEY

Writing Skills of Engineering and Science Students

A properly structured senior course is advocated by the author. Such a course would include problems in organization, format, and precision of expression and would yield writers trained in the efficient transfer of information. Juanita Williams Dudley is in the Department of English, Purdue University.

For many years teachers of college English have suspected that undergraduate engineering and science students, without instruction in expository writing beyond the freshman year, deteriorate in their ability to communicate in writing. This suspicion is based in part on the knowledge that the average engineering or physical science student may, from his earliest school years, have preferred the study of science or mathematics to the study of literature and composition and that many college curricula abet such a student in further narrowing his interests by requiring no more than nine quarter-hours or six semester-hours of instruction in writing and the study of literature.

This impression has also been fostered by employers who imply that their graduate engineers and scientists often do not command the communication skills requisite to the successful performance of their duties. Further support has been given to the hypothesis by a report on a survey conducted by the Joint ECAC Feedback Committee of the American Society for Engineering Education. The survey, based on responses to a questionnaire asking graduate engineers to list their highest subject training needs (seen in retrospect), indicated that most respondents placed technical writing second only to management practices.[1] The inference made by many English teachers (including the principal investigator on this project) was that, if graduate engineers view training in technical writing as a real need, they probably deem mere freshman English as inadequate training for the writing tasks confronting them in the postgraduate world.

In this study, the investigator proceeded on the assumption that most engineering students are, despite their keen interest in science and technology, as naturally well endowed with the ability to write coherent and forceful English prose as are students majoring in the humanities. The assumption was partially generated by an awareness of a study conducted in 1953 by Prof. R. P. Weeks of the University of Michigan. Prof. Weeks reported that no significant differences were detected between vocabulary skills, reading speed, and comprehension of a group of 100 Michigan engineering freshmen and a group of 100 students of the College of Literature, Art, and Science.[2]

The contradiction between this evidence of fair writing ability in engineering freshmen and the general impression among employers, English teachers, and graduate engineers that people in scientific and technological disciplines have serious writing problems suggested that some circumstance—perhaps an almost exclusive preoccupation with mathematical rather than verbal symbols—diminished language skills between the time a student completed freshman English and the time he graduated from college.

A Statement of the Problem

Accordingly it was hypothesized that students majoring in engineering and science need instruction in expository composition at a level beyond that of the freshman year and the completion of the traditional courses in freshman English, and that skills in expository writing tend to deteriorate between the freshman and senior years in a science-oriented curriculum where the prevailing preoccupation is with mathematical rather than verbal symbols. It was hoped that a series of writing tests, if administered to five groups of students—one group of freshmen, one group of sophomores, one group of juniors, one group of seniors, and one group of juniors and seniors who had completed a course in technical writing—might confirm or deny the hypothesis by making possible a comparison of individual with individual and class with class. If the hypothesis were proven true, the implication would be that engineering and science students sorely needed at least one composition course beyond the freshman complex, probably in the junior or senior year. If the hypothesis were proven false, then the implication would be that some factor other than deterioration is responsible for the general impression that scientists and engineers cannot write well in line of duty.

Not the least of the difficulties involved in an attempt to confirm or deny the hypothesis was the choice of suitable instruments for testing. The validity of writing tests has long been a bone of contention among educators. Since 1927 the College Entrance Examination Board has sought a means of objectifying graders' judgments of writing samples. In 1946 Noyes, Saie, and Stalnaker reviewed the data from six different one-hour essay examinations and concluded that the reliability of the reading had been too low to satisfy College Board standards. In 1953 Pearson evaluated an experiment with a two-hour General Composition Test but reported that it was no more reliable than the shorter essay examinations used in earlier years. Eventually it became patent that the unreliability of essay tests stemmed from: 1) the difference in quality of student writing from one topic to another, 2) the different opinions among readers about the characteristics of good writing, and 3) the distortion in values produced by analytical rather than holistic reading. The problem of assessing a paper was further complicated by the difficulty of finding a logically sound criterion of composition skills.

Thus the principal investigator for this project was faced with the necessity of finding tests of writing ability that would not be unjustly discriminatory because of the assigned topic's special appeal to the verbally gifted or widely read student, that could be graded according to criteria established *for* but not *by* the readers, that could be rated according to holistic rather than analytical reading. At the same time, some means had to be employed for discovering how students varied in particular writing skills (such as organization, the appropriate use of conventions, and critical thinking) according to their year in college, their curricula, their previous training, and their native abilities. It was felt that at least two essay tests (to be graded holistically) and at least one objective test (to yield subscores on specific skills) were required.

The Tests

All of the subjects ultimately included in this study took 140 minutes of tests—the Sequential Test of Educational Progress (STEP) Essay Test (Forms 1A and 1C) and the Sequential Test of Educational Progress (STEP) Writing Test (Form 1A).

The Sequential Test of Educational Progress (STEP) Essay Test (Forms 1A and 1C)

The STEP Essay Test, published by the Educational Testing Service, is a free-response test of writing ability. The principal investigator deemed it appropriate to this study because, according to the Educational Testing Service, it is designed to be rated holistically, rather than analytically,[3] because the free responses rated according to models will theoretically result in a significant degree of reliability among readers,[4] and because the writing topics appeared to have a universality of appeal.

The Sequential Test of Educational Progress (STEP) Writing Test (Form 1A)

Despite its name, the STEP Writing Test is an objective test, made up of 60 multiple choice questions, 30 questions to each of two parts. It is, according to the Educational Testing Service,[5] designed to test specific writing skills, namely,

1) organization (the ordering of ideas),

2) the use of conventions (syntax, sentence structure, diction, punctuation, and spelling),

3) critical thinking (detection of unstated assumptions, logical relationships, and anticipation of the reader's needs),

4) effective presentation (adequacy of emphasis and development, precision and conciseness of expression), and

5) the appropriate choice of level of usage.

The Subjects

Between April 25 and October 25, 1968, the two STEP Essay Tests and one STEP Writing Test were administered to 361 Iowa State University students majoring in science or engineering. Twenty-five different curricula are represented, most of which are presumed to be primarily concerned with quantitative rather than verbal symbols.

Subjects were volunteers, some paid, some recruited by telephone calls, letters, advertising, and appeals to classes.

There were 72 freshmen, 70 sophomores, 71 juniors, 74 seniors, and 74 students who had completed or were about to complete English 414 (the Writing of Reports and Technical Papers). All freshmen had to be in the latter third of their last quarter of freshman English at the time they took the tests and, in order to be included in the data, had to pass that quarter. (The freshman English complex at Iowa State totals nine quarter hours.) All sophomores, juniors, seniors, and 414 students had to have completed freshman English with a passing grade, but were not eligible to take the tests if they had taken composition courses beyond the freshman complex. The stipulation that subjects should not have taken additional English courses did not apply to freshmen inasmuch as they are not allowed to take anything but freshman English.

There is a significant difference between the means of composite scores of those students who took both parts of the writing test second and those who took it first one or both times, but those students who took both parts of the objective test first had only the third highest mean of the possible four.

Of the means of those tests taken by the subjects before or upon entering college, those of the ACT and MSAT totals had the highest correlation with the composite scores. Neither the scores on the English Placement Test (1—Cooperative English Test, Single Booklet, Higher, Form T, ETS) nor the average of the freshman English grades correlated highly with the composite scores. Grade point average correlated most poorly of all the covariates (Table 2). The reliability among the three readers of the essay tests was 0.74.

The correlation between the total score on the writing test and the composite score on the essay tests was 0.38—the same as the correlation between the total of the writing test and the composite score for Essay 1C (Table 3).

Discussion

This study has disproven the hypothesis that undergraduate engineering and science students deteriorate in writing ability between the time they complete freshman English and the time they graduate. Although there were slight differences among the means of the five categories, none of them were large enough to be significant. One

Table 1. The Means of STEP Essay Tests and STEP Writing Tests by Subject Category

Category	*Essay 1A*	*Essay 1C*	*Essay Total*	*Writing Part 1*	*Writing Part 2*	*Writing Total*	*Composite*
Freshman	11	11.5	22.5	20	19	39	61.5
Sophomore	12	12	24	21.5	21	42.5	66.5
Junior	11	11.5	22.5	22	20	42	64.4
Senior	12	12	24	21	20	41	65
414 Students	12	12	24	21	21	42	66

Table 2. The Correlation of Composite Scores with Covariates

Covariates	*All Students*	*414 Students*
Freshman English Grade	0.43	0.44
ACT Total	0.37	0.55
MSAT Total	0.47	0.49
English Placement (1)[a]	0.44	0.43
English Placement (2)[a]	0.50	—
High School Rank	0.39	0.40
Grade Point Average	0.34	0.30
414 Grade	—	0.34

[a] Until September 1966, I.S.U. freshmen took the Cooperative English Test, Single Booklet, Higher, Form T, ETS. In September of 1966, this form was replaced by the Cooperative English Test. English Expression, Form 1C, ETS. The designation (1) indicates the earlier test. The designation (2) indicates the later test. Because only 414 students had taken the later English Placement Test, the correlation of this variable was not considered relevant.

Table 3. Correlation of Means of Essay Tests with Means of Writing Tests

Essay Tests	*Writing*	*Correlation*
Composite 1A & 1C	Total, Parts 1 & 2	0.38
1A	Total	0.23
1C	Total	0.38
1A	Part 1	0.21
1C	Part 1	0.34
1A	Part 2	0.19
1C	Part 2	0.29

might conjecture that the rate of attrition among less able engineering and science students tends to maintain the original mean of competence. But such a theory fails to take into account the able students who first choose engineering or science majors but later discover they want to major in the humanities.

If the findings of this study are at all representative, some more reasonable explanation must be found for the general impression that graduate scientists and engineers do not write well. There is always the possibility, of course, that because of their predispositions, students in technological and scientific disciplines graduate and heave a sigh of relief at the prospect of never again having to worry about a squinting modifier or a sentence fragment. But engineers and scientists are often at the helm of important national enterprises. Surely such people have a concern for the clarity and propriety of their communication.

A much more credible reason for the impression is that the nature of engineers' and scientists' jobs forces them to work and write under pressure, and to write more accurately and frequently than do people in other professions. Most engineers have many reports to write. Furthermore, in the plant or laboratory the development of the process or technique is of primary importance, and the description of that process secondary. Add to the exigencies of a crowded schedule the constant threat of one's training and knowledge becoming obsolete, and the average engineer or scientist is confronted with the necessity of reading assiduously, researching exhaustively, and reporting perfunctorily. His problem is compounded by the fact that not only must he write under pressure but he must write *with an intimidating degree of accuracy* under pressure. Without question, his writing must be more precisely adapted to practical application than the writing of an English teacher or sociologist. The consequences of a specification for a "fastener" rather than a "10-32-NF threaded stud and nut" can be catastrophic to an astronaut dependent for his life on the smooth functioning of his spaceship. And certainly there is more immediately at stake in a report on a craft's airworthiness than in an evaluation of a proposed new textbook or a survey of community attitude toward low-income housing.

Thus the responses to the joint ECAC Feedback Committee's questionnaire may be assumed to mean exactly what they say—that graduate engineers wish they had had more technical writing as undergraduates. They do not, apparently, wish they had had more general composition. They have evidently found in their postgraduate experience that they need instruction in a very special kind of writing. What they failed to get in college, perhaps, was a course that would enable them to write a report without spending hours deciding how best to organize facts, display data, and adopt the right tone for the intended reader. Those who had a course in technical writing may have considered it inadequate because it was taught as just another general composition course and too little time was spent in training students to translate scientific logic—sometimes instinctual and often unverbalized—into sentences and paragraphs which replicate for the reader the actual sequence of the investigator's or expediter's ideas. Such a course—placed in the senior year and including problems in organization, format, and precision of expression—might arm the engineer or scientist with enough automatic responses to make writing under pressure a more mechanical and therefore less time-consuming process.

Altogether, tests were administered to 424 students, although 63 of the tests had to be discarded for various reasons.

Method of Analysis

The data collected were subjected to a complete regression analysis in order to 1) compensate for the lack of randomness in the selection of subjects, 2) yield information about the relative writing skills of the five categories, and 3) discover the interrelationship of such variables as test scores and the sequence in which the tests were taken, test scores and the subject's curriculum, test scores and freshman English grades, earlier test scores, high school rank, and grade point average. Also through the regression analysis, the mean score on the essay tests was correlated with the mean score on the writing tests, and the reliability among readers was established. For statistical purposes, curricula were categorized in six large groups.

The plan to break down the writing test scores into subscores was abandoned because the reliability estimate was only 0.72 as computed by KR-20. Since reliability, or measurement accuracy, depends on interitem correlation and the number of items, it was inferred that any analysis of subscores would be meaningless because of the small number of items in each subscore.

Although the original research design (as detailed in the proposal) implied that the five groups' performance on the essay test would be evaluated through the chi square test of independence, Dr. John W. Menne, the statistician for the project, felt that the regression analysis was a method which would give much more precise measurements than the chi square test, particularly with as large a sample as 361 subjects.

Findings

There appear to be no, or only minimally, significant differences in the means of the scores of the five categories (Table 1). Although the freshman means are either the lowest or among the lowest of those of the various categories, the five-point difference between these means and those of the sophomores and 414 students is probably not highly significant. Similarly, although the sophomore means are slightly higher than those of any other group, the differences are too slight to be significant. The means of the 414 students are the next highest, but again are not enough higher to warrant speculation on the cause.

In the regression analysis it was found that the effect of sequence accounts for more of the variance than do either the effects of curriculum or category. Even so, the greater significance of the sequence effect's variance is probably more a function of the large size of the sample than a meaningful difference.

The means of the significance of the four possible sequences were: (1-1) 7.03; (1-2) 9.51; (2-1) 10.77; (2-2) 6.23. The third sequence might indicate that taking the objective test second at the first testing session constitutes a more favorable set of circumstances than any of the other sequences.

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J. RICHARD JOHNSON

Communications—the Engineer's Job

In today's world, states the author, the engineer must communicate better than ever before, and the engineer who recognizes that communication is a vital part of the profession has taken a big step toward professional success. J. Richard Johnson is employed at Bell Telephone Laboratories, Whippany, New Jersey.

It is getting to be a bit trite to tell the engineer how vital it is that he communicate with other human beings. There has certainly been no lack of advice for him on this score. Most of it is quite general, of an almost evangelical nature, warning him that he should be against sin and assuring him that the road to communication heaven is paved with pleasant simple formulas. If the engineer will just take the paternal advice of the publications expert salvation is his. I believe many of the failures of the engineer to communicate better arise from a negative reaction to this insult to his intelligence.

It is no wonder he is indifferent! He is constantly besieged by exhortations to use the simple word, the short sentence, the Anglo-Saxon word, and to follow a neat set of grammatical rules handily indexed in a book that can be consulted with almost no effort. The engineer is encouraged to dismiss the writing job as consisting of such superficialities as how to write a good sentence, how to make the verb agree with the subject, or how to organize a paragraph.

Surely these things are very important; they are things you have to know to write well. But by themselves they have no significance because they are not the basic stuff from which human communication is fashioned. They are simply the tools with which human communication is accomplished after the thinking phase of the communication is finished.

Human Communication Is Mental

The process of human communication is essentially mental and the engineer's mastery of it is a goal that cannot be separated from himself as a person and all his other talents.[1] It is not just a technique, but a profound thinking effort calling upon the resources provided by all his education, experience and personality. My observation is that when the good engineer recognizes a writing or speaking project as this kind of challenge, he becomes interested, orients his attitudes, seeks out the help he needs and gets the job done. The syntax and the rhetoric somehow take care of themselves if the incentive and respect for the job are established.

This line of reasoning should not be construed as a categorical criticism of instruction in technical writing or of technical writing courses. I do, however, take issue with the philosophy of courses that start with the technique end of the business, and never get any further. There is reason to doubt about whether writing in its complete sense can ever be taught as such, because its essential mental processes are really integral with the subject matter. In other words, the man who knows his business and is well organized is at the same time almost automatically prepared to write or speak about it. A really complete writing course would then have to concern itself with the student's understanding of his trade or profession. If I had my way, all college courses would be reviewed to make sure technical subjects are taught so as to encourage the student's faculty and desire for communication. However, I believe definite progress has been made in technical writing courses in which the student is forced to "think through" the steps he must follow to implement communication.[2]

Overspecialization—Enemy of Communication

One of the greatest handicaps we all are facing in all our endeavors, and in human communication in particular, is the unfortunate trend toward "splitting" the engineer into small pieces, toward separating him from many of the great attributes he should naturally possess as an educated and responsible individual. I call this process "human fragmentation." Its annoying course is encouraged by that of its corollary: overspecialization. I have seen want ads for transistor engineers, digital and analog engineers. We even have human engineering engineers. We have value analysis engineers, who look back at their work and that of their colleagues to see if someone forgot or neglected to do something a better way.

Now I am not criticizing what these people do; many of them are excellent engineers doing fine work. What I do object to is the implication that, as people, these engineers fit into a thin mold. I object to the failure by many to see that, of these specialists, the ones who are really good are the ones who star in the human attributes which make any engineer or any other professional either good or poor. I object because this is the same thing that is discouraging many engineers from developing their own communicating ability. They have been given the feeling that writing should all be turned over to a technical writer or some English major who, though not knowing the first thing about the basics of the subject, has such a "tremendous familiarity with technical terms," a copy of Fowler or Evans, and such a nice typewriter with Greek letters on it, that supposedly he can make a better job of the paper or report than the engineer could.

Technical Writers and Editors

Do I resent technical writers or technical editors? Of course not. They have an extremely important part in our technology. But just as I feel it's part of the engineer's job to write and speak, I feel it's part of the technical writer and editor's jobs to be technical in a deep understanding way. These people may not be engineers but they are, like engineers, primarily humans. Thus in both cases it is the background and experience, the general education, the dependability and sense of responsibility that mark each person as a unique human that count. If the technical writer or editor is to do the right kind of a job on the engineer's paper or report, he must think like an engineer, which, unfortunately, many of them don't do. This is not so very surprising, because when it comes to writing, many engineers forget to think like engineers because they are still thinking of human expression as somebody else's job.

Are Engineers Unable to Write?

Some who observe the engineer's failings in communication love to raise the cry "Engineers can't write" implying that there is something inherent about an engineer that prevents him from expressing himself on paper. As far as I am concerned, this is rubbish!

As professor Thomas Farrell, of Michigan State, chairman of the Project Planning and Research Committee of this professional group has put it: Isn't it ridiculous to say that a man who, in several years has mastered such subjects as mechanics, calculus and thermodynamics lacks the potential for expressing himself clearly on paper or on the speaker's platform!

Certainly the engineer, with years of education in back of him, is basically eminently qualified for human communication.

Why Do Engineers Have Communication Difficulty?

But the fact remains that many engineers realize that they are not communicating as well as they should and in failing to do so they are handicapping themselves and the projects on which they work. Why do they have a problem? Why is there such a feeling that we, as engineers, are not writing and speaking well enough to meet the complex needs of our modern environment?

The reason is that we fail, in trying to write or speak, to focus our whole mental capacities on the job of human communication. We just don't think hard enough about the job of self-expression. We have succumbed to the mechanics, the superficial "experts" and their formulas. We are, by simple default, surrendering our great opportunities to advance ourselves and our work.

This is particularly unfortunate because self-expression is so vital to the success of an engineer's efforts. He cannot operate in isolation. Sooner or later he must communicate. If he does not put just as much thought and energy into communication as he does into his other important efforts, these other efforts may be of little avail.

Good Communication Requires Motivation

Let's face it, good writing is not easy. It requires the engineer's thought and energy as much as anything he does. Crystal clear transmission of information about his work and his opinions is a goal worthy of pride and satisfaction. I am convinced that when an engineer becomes aware of this fact all other obstacles to good writing are relatively insignificant. When a man has a real burning desire to communicate, he finds a way!

This fact about the motivation to communicate was very well put by Mr. M. Brotherton, of Bell Telephone Laboratories at this group's Michigan State Symposium in 1961, when he said:

> Consider for a moment the stupendous, overwhelming communicating power of an angry woman . . . . I'm sure everyone here knows what it is like to have a situation explained to him by an angry housewife, some of us perhaps in our own homes. Does anyone ever do a better job of communicating? The ideas she seeks to convey emerge from her mind as though jet propelled, and they penetrate the mind of the listener with blinding clarity. When she gets through you know exactly what she has in mind without any shadow of doubt.
>
> Now isn't this odd when you consider that this housewife may never have studied the art of communicating . . . . She may not even be aware that there is such a thing as an art of communicating.
>
> Why, then, is she so successful? . . . I submit the principal reason is that she is utterly determined to communicate. She really means it.

We need to take a lesson from the angry housewife. We can always get things across better when we really mean them.

Great Men Communicate Naturally

The simple fact is that good writing requires, and usually goes along with, good thinking. The great scientists of history came by their writing ability naturally. (An outstanding example is a man whose work recently attracted many thousands to this city every day.) I mean, of course, Leonardo DaVinci. Although the Mona Lisa represents the result of his work as an artist, he was also an outstanding engineer. Although he is not ordinarily extolled as a writer, he was an accomplished one. He was educated in the broad sense, knew well what information he wanted to transmit, and had a burning desire not only to generate ideas, but to pass them along. His famous book *Treatise on Painting* is a work of art that has been consulted through the ages, and there are in existence to this day nearly 7,000 pages of his excellent notebooks. DaVinci wrote as he did because he was a good artist, a good engineer, in other words a successful human being.

And so it has been with great men in all walks of life. Communication with their fellow men was accomplished as thinking humans, not as engineers, mathematicians, or even as grammarians. Look up the ladder of success in your own management. I'm sure you will notice, as I have, that most of the really successful people, both engineers and other professionals, are good communicators. They may not be able to identify a dangling participle or even a split infinitive, but they can take your manuscript and tell you whether you have made a point and are getting it across.

I am sure that most of these people have not consciously prepared themselves as writers. I doubt if any appreciable number are even aware of their ability in that field. I think that their success in their careers stems in large measure from the fact that they have, often only subconsciously, recognized writing as an integral part of their profession; they have intuitively acted in accord with the fact that you can no more separate engineering and writing than you can separate engineering from statics or calculus. The thought processes in their day-to-day work and in the management of any job are the same as are required for good writing.

This works both ways. The thinking processes used in putting ideas in clear form on paper are equally useful in your research and development work. As a colleague at Bell Laboratories recently expressed it to me: "No idea has really matured until it can be written down clearly enough for others to understand." If you want to see how well you're planning your engineering work, try writing down a clear account of your progress to date, your status, and your plan for the future.

Do We Have Time for Communication?

Often, when one suggests that the engineer do his own writing and speaking the answer is "We don't have time." We are told that the engineer does not have time to do development or research work and write about it also. One answer to this is that it is those engineers who have perceived self-expression as part of their job who have most frequently been successful. But lest he think of this as altruistic, let me ask: "Does he have time to read a meter, operate a switch, use an oscilloscope, or record data?" As a physical entity, each of these things is far simpler than turning out a good piece of writing. But used by him as a whole responsible person, for an integrated purpose, how significant any one or all can be!

Of course development or research engineers cannot do all the writing for a large R & D research job. There are manuals to be prepared, many reports to be made, vital routine documentation to be done.

But significant ideas, exact interpretation, proper emphasis and other vital necessities concerning the transmission of information about his work must be supplied by the engineer who is doing the work. The more steps he places between himself and the printed word or oral presentation the greater the danger of distortion and failure to communicate.

Examples

One of the essentials of good communication is that one should never become too abstract. Accordingly, lest I commit such a sin, let me provide some examples to illustrate my point that communication is primarily mental in nature.

My experience at the Bell Laboratories has been primarily with progress reports. Accordingly, my examples are from that field, to ensure authenticity. They are the exact types of things we have had to cope with in our engineering reports. However, to avoid any possible chance of reflecting on any individual, the exact wording has been substantially changed.

Here is an example typical of some of the material we have received:

> A proposed plan for providing temperature control has many advantages. The use of thermocouples, diodes and transistors makes it extremely light and compact. Temperature accuracy of the thermocouples is the best of any devices available and transistors are known to have long life. However, it has been decided not to follow this plan but to use an alternative device employing vacuum tubes.

Notice how the writer spends valuable time and words to build a case for a plan that will not be adopted. Perhaps he is inwardly piqued that the proposed plan is not being adopted. In any case, it is his mental approach that is introducing distortion into his story. How much more simple and efficient to say:

> Transistor-diode devices have been considered and, although they have more advantages, their use has been discarded in favor of a vacuum tube device which costs less and has field-demonstrated reliability.

Often a writer will allow immediate difficulties, even though petty, to interfere with proper perspective. Consider the following example:

> Great difficulty was experienced with the adjustment of the third lock screw on the left side of the device. There were also other difficulties,

> involving mistaken reading of notes and the manner in which the data should be tabulated. These things and a subsequent oil leak were corrected and full power was achieved for the first time since development started a year ago.

In this example, the great, outstanding event being reported, which is that "full power was achieved for the first time" is buried beneath a great pile of trivia.

In both of these examples, typical of most of the real problems of writing by engineers, it is the thinking processes preceding the actual mechanics of writing that are at fault. No course in the simple word, the short sentence, or in English composition alone can make the writer think more clearly about the ideas he is trying to transmit.

These examples are not isolated instances, but are typical of the problems being encountered every day by engineers and other professional people.

What to Do about It

In summary, what do I say the engineer should do about it? My advice is as follows:

1) Recognize that self-expression is a noble, demanding, mental effort worthy of the best in you and worthy of serious eager consideration.

2) Recognize that self-expression is a vital part of your work as an engineer and give any jobs involving it the priority they deserve.

3) Recognize that self-expression is one of the most effective avenues to success, that it is a personal attribute that can make the difference in whether you will succeed or not.

You will notice that each item calls only for the "recognition" of certain conditions. This is because I have enough appreciation for the worth of an engineer to know that once he recognizes a need he will best find the answers to the mechanical problems of implementation by his own efforts.

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HERMAN A. ESTRIN

Engineering Alumni Discuss English

Freshmen engineering students are advised by alumni to master English, the one subject they will need more than any other throughout their lives. Herman A. Estrin is in the Department of Humanities, New Jersey Institute of Technology.

What advice would you give a freshman concerning the study of English in an engineering curriculum? This question was asked of two hundred alumni of the Classes of 1949, 1950, and 1951 of Newark College of Engineering. They answered as follows:

1. Approach English as you would any task. Work as hard at it as you need to become proficient. English is governed by rules and laws as are all technical studies. Learn and use them.
2. Utilize every opportunity to write; and in writing, practice conveying ideas clearly and concisely.
3. Treat English at least as importantly as any technical course and get as broad and comprehensive an English background as possible.

4. Become proficient in expressing yourself on paper. Develop the habit of writing all decisions, since industry tries to avoid verbal orders.

5. Learn the fundamentals of grammar well. Learn how to present ideas, to put important things first, and to eliminate the irrelevant.

6. Learn to write technical papers and learn to read them. Learn how to organize and present a technical report verbally through use of charts and graphs. Above all, learn how to spell! Misspelled words create the same impression as gravy stains on a necktie.

7. Concentrate particularly in acquiring the ability to write clear, concise letters and articles. Master completely not only grammar forms but also rhetoric. Become thoroughly able to think and speak on your feet.

8. Treat English I as you would Physics I or Chemistry I. *The pen displaces the slide rule as an individual advances in engineering.*

9. Pay close attention to the assignments. Advancement in business (including greater remuneration) can be achieved only by people who can express their thoughts and desires in a manner that will make them be listened to by others. This can be accomplished only by speech or composition.

10. Use your teacher harshly as your critic. English is a subject as important as any of the rest, and you cannot afford the luxury of letting the teacher set the pace.

11. Take English, but study *communication*. This, more than any other quality which you may possess, will set the rate and extent of your professional advancement.

12. Learn sentence structure and write intelligently. I think that men should be made to read other men's compositions and reports to see how miserably most people write.

13. Do not consider English as a secondary subject. It can be more valuable than any technical course. More responsibilities given to a person in his job usually mean more administrative functions—resulting in less slide-rule work and greater need for effective English to communicate ideas and policy.

14. If you do not succeed in mastering Engineering, be certain to obtain a mastery of English. *For in the end it will be the one subject you will need more than any other during your lifetime.*

4

Technical Writing Teachers Appraise the Curriculum

THOMAS M. SAWYER

First Things Last: Composition for Seniors, Not Freshmen

Freshman composition should, the author feels, be designed for seniors. He describes the stage at which composition is taught to engineering students. Thomas M. Sawyer is in the Department of Humanities, College of Engineering, University of Michigan.

For a good many years I have been convinced that college courses in freshman composition or communication are largely a waste of time and money and should be eliminated. Composition and communication should be taught where they belong—in the senior year when the student has something to say and wants help in learning how to say it.

Here are some facts which I hope will persuade other teachers of composition and communication to adopt a program similar to the one my own department now follows.

In *College English* for March, 1968, Tom Wilcox reports on a survey of college English departments across the country and finds that the English department is the largest department on 72% of the campuses he surveyed. What he means by "largest" may be illustrated by some Michigan universities. At Central Michigan University my friend Lawrence Dawson heads a department of 90 English teachers. At Eastern Michigan University, Milton Foster heads a department of 140 teachers of English. And on my own campus in Ann Arbor, if you should add the English teachers in Russell Fraser's department in the Literary College to those in the Humanities Department of the College of Engineering, you would end up with a total of about 164 people. On any one of these three campuses the English teachers number more than the entire faculty of many a small college.

On the Ann Arbor campus of the University of Michigan in 1965–66 these 164 English teachers taught a total of 46,833 student credit hours. At three credit hours per student, these teachers were confronted with 15,000 bodies, or about 7,000 per term. The next largest department was Mathematics, 10,000 student credit hours smaller, then Psychology, 10,000 student credit hours smaller than Mathematics.

Tom Wilcox finds that just about half of the work of most of these teachers is in freshman English. And figures at the University of Michigan bear him out. The Ann Arbor campus of the University of Michigan admits approximately 3,500 freshmen per year and all of them must take freshman English; there is half of the 7,000 bodies. Wilcox finds that 78% of the colleges in his survey require two terms of freshman English. Now that is a large and expensive operation and, in the eyes of a good many people, it is a large and expensive failure.

How then is freshman English taught? Wilcox finds that about 48% of American colleges and universities devote the first term of the regular course exclusively to composition. The other 52% presumably mix literature and composition and some daring departments have made freshman English a literature course entirely. Bonnie Nelson's survey of freshman composition courses published in the September, 1968, *Bulletin of the Association of Departments of English* reveals that there is no agreement on how freshman English should be taught. The report contains the interesting and illuminating sentence, "Ironically, one director frequently describes an innovative program which another director happily announces he is abandoning."

After attending a number of conventions of the National Council of Teachers of English and of the Conference on College Composition and Communication, I am pretty well persuaded that there is no consensus among teachers of English about how freshman composition should be taught, and I am expecting that the next survey Bonnie Nelson conducts on freshman literature courses will indicate that there is no consensus about that either.

This leads to a third aspect of the situation. Is there any way of determining whether or not one way of teaching freshman composition is better than another? In the September, 1969, *Bulletin of the Association of Departments of English*, Tom Wilcox reports that only 20% of the departments surveyed used common examinations in sectioned courses. He means common examinations within their own departments, not examinations used in common by two or more institutions. The conclusion to be drawn from this seems clear. English teachers have only the foggiest idea how the students they teach compare with the students taught by their colleagues in the same department and absolutely no idea how their students compare with others in another college. Law students are compared when they take the state bar exam; medical students must also be state licensed; engineers have the Professional Engineers exam. Since students of English are not thus tested for quality, Tom Wilcox asks, "Is English a discipline or an activity?"

Of the two alternatives Wilcox suggests, it seems to me that one must choose activity. I have seen no evidence that English is a discipline in the sense that the sciences are. The teaching of English seems to be what Tom Wilcox labels as an *activity.* I have rarely seen English teachers agree on how anything should be taught. As my esteemed colleague across the Michigan campus, Professor Warner Rice, replied when asked the opinion of the English Department on some matter, "The English Department does not have an opinion, it has opinions."

This then is the situation. The English Department is the largest department in most colleges; the greater part of its effort is spent on freshman English; there is no consensus on how this course should be taught; and no one knows whether the way he teaches it is effective or not.

I am not at all surprised that Deans William Buckler, Robert Rogers, and Hoyt Trowbridge all sound the same note. In effect they all ask, what in the blazes do you fellows accomplish for all the money we are pouring into the largest course on the campus? And we reply, why, we are improving the students' ability to write, Sir. Fine, can you prove it? Alas, Gentlemen may cry, Proof! Proof! But there is no proof.

The Typical Freshman Course

How did this situation come about? What follows is my own view and you may disagree with this diagnosis.

First—those assigned to teach freshman composition have little or no training in rhetoric and are seldom interested in it. The transcripts of recent Ph.D.'s applying to our department rarely, if ever, include courses in rhetoric or composition. A course in linguistics or the history of the English language may appear, but far and away the greatest number of courses listed are in literature. Moreover, the dissertation is nearly always a critical study of some literary figure. It is not at all surprising that these people find it hard to agree on how composition should be taught to freshmen. Further, it is not at all surprising that they would like to call upon their background in literature. Inevitably then the freshman composition course drifts gradually into a discussion of literature with some compositions thrown in through which the student is asked to analyze works of literature. Unfortunately, in his later academic and professional career the student will be required to write letters of application, policy proposals, instructions, and economic justifications—not literary analyses. For this reason freshman composition based on literature will have little of that now magic ingredient, "relevance," for students other than potential English majors.

Second—consider the students. In *Biography: The Craft and the Calling,* Catherine Drinker Bowen writes: "Surely, all education and the shaping of intelligence is a matter of learning how to compare, the storing up of experience to have points of comparison on hand." And "clarity and seduction in English prose are not easy to achieve; the one stems from clear thinking and knowledge of one's subject; the other is a reflection of the author's personality, his outlook on life, his likes and dislikes, his loves and hates."

Students in freshman composition are about 18 years old, just five or six years beyond puberty, and until very recently, three years from being mature enough to vote. Legal age restrictions have usually prevented them from working at any but the most menial jobs and from indulging in matrimony. Few if any of them will have visited outside of the United States and many of them have traveled little beyond their state boundaries. For thirteen years they have spent two-thirds of each year in school. There they have learned some fundamental skills—how to read and spell, multiply and divide, cook, sew, drive a car. And they have learned some fundamental facts—

that water is composed of two parts hydrogen and one part oxygen, that the U.S. is now composed of 50 states, that a body at rest tends to remain at rest.

This body of facts and skills will be common to all of them and to the instructor. If one accepts Miss Bowen's view, to ask these students to write *clearly* means asking them to write about subject matter they and the instructor all understand equally well. The exercise becomes an artificial one since there is no point in writing to someone about a subject he knows anyway. Thus to the student the course is a grind.

Perhaps one can ask them to write seductively. But these young people have rarely stored up enough experience to have points of comparison on hand. They will have likes and dislikes, loves and hates all right, but these are ordinarily based upon such a limited outlook on life that the instructor struggles desperately for a theme topic that will elicit more than a mere gush of puerile enthusiasm or a juvenile temper tantrum. The class begins to sound like a sensitivity group or a rap session.

It is little wonder that classes entitled *freshman composition* which bring together students such as these with instructors interested primarily in literature, are likely to take on a bewildering variety of formats and tend to drift toward discussions of literature rather than training in rhetoric and composition.

Dean Buckler says: "I believe that as soon as a college can get out of the whole business of freshman English, it should." I think he is right! It may be, as some of my colleagues trained in rhetoric suggest, that a way could be found to teach freshman composition effectively. But the very number of students and teachers involved seems to me to pose insolvable difficulties.

Why not get at the root causes of the matter? If the English teacher likes teaching literature and the freshman needs stored-up experience in order to have points of comparison, why not combine desire and necessity, abandon freshman composition as Dean Buckler suggests? Since our students know little of the past—as Paul Goodman argues, history for them begins with Chicago 1968—why not fill them with the experience stored up by others? Who should better be able to show them the past than the man who is steeped in it—the teacher of literature? This argument was persuasive enough to convince the faculty of the College of Engineering to permit us to replace six hours of freshman composition and speech with six hours of Great Books.

This replacement was based upon two years of experimenting which provided evidence in the form of student evaluations that Great Books courses were much more popular, and perhaps, therefore, more relevant and effective, than freshman composition.

But proposing to eliminate training in rhetoric altogether will run headlong into serious opposition from the faculty of other departments. The ability to write is an essential skill for advancement in any professional discipline, as it is for any educated man and citizen of a democracy. Moreover, it is essential to the public at large that specialists and professionals be able to explain and justify the policies they propose if we are to make wise decisions about public policy. A survey conducted by the American Association for Engineering Education revealed that over 64% of those who had graduated 10 years before desired more and further training in writing. In ten years they had risen to the ranks of management and they were now dealing with people, rather than things. They had come to realize that if they fail to write clearly and persuasively, they fail—period.

What then is to be done? If freshman composition fails, but training in rhetoric is needed, what is the way out?

Composition in the Senior Year

The solution we proposed was to place training in rhetoric and composition where we think it belongs, in the senior year. First and foremost because the students are different. By the senior year their courses have diverged from the common core of experience they began with as freshmen. Civil engineers now know things that electrical engineers do not. They speak different languages and often cannot understand one another. Moreover, by the end of four years they have come to recognize that training in rhetoric is important, they welcome criticism, and work willingly and conscientiously on their papers.

Although I have used engineering undergraduates to illustrate, I believe that the same holds true for senior students in a liberal arts college. At least it holds true for the science majors who come across the campus to enroll in our senior and graduate course in scientific and technical writing. But the engineer cannot avoid the value decisions that occur when this technology has a social or political impact. So our senior rhetoric course will be offered in alternative versions, not limited to scientific and technical writing.

Thus, in effect, we have turned our sequence of courses upside down—classic literature providing an historical perspective for freshman, specialized courses in literature for juniors, and rhetoric for seniors. We are, I think, all persuaded that the first part of this program works for both students and teachers. We are also persuaded that the last part of this program makes good sense for students. We hope it works for teachers as well. Fortunately, we have on our staff a number of people interested and competent in rhetoric as well as literature. And fortunately some English departments are becoming interested in offering graduate programs in rhetoric and we are beginning to get applications from people who see the opportunity to teach senior and graduate students as an opportunity for important and exciting research in an expanding field, a field which is at once very old and very new.

W. EARL BRITTON

The Trouble with Technical Writing Is Freshman Composition

Because he believes that technical writing, which emphasizes efficiency, precision, and communicative effectiveness, is applicable to all fields, the author wants to replace freshman English with technical writing. W. Earl Britton is in the Department of Humanities, College of Engineering, University of Michigan.

There is so much wrong with freshman English and so much right about technical writing that I suggest they trade places in the academic scene. This exchange would reverse the present arrangement by requiring technical writing courses of all college students, who could then elect specialty subjects like essay and creative writing if they wished.

I'll begin with the weaknesses of the English course normally given to freshmen.

1. It concentrates on the composition of essays, often in connection with assigned readings, and usually in the form of responses to the material. Insofar as the assignments focus on thought and logic, they have point; but I begin to have my doubts when the emphasis turns to originality and something vaguely labeled literary quality. And there is the matter of the essay itself. Is it realistic to build a writing course around a form of composition that is rarely if ever pursued by the graduate in his professional life?

2. The direction of the writing, that is, the flow of information, proceeds from an ill-informed freshman to a well-informed instructor,

primarily because the instructor insists that it be that way. He argues that he can assist the student only by knowing more about the material than the writer does.

3. The emphasis in these essays rests on thought quality and rarely upon communicative effectiveness. It would be absurd to derogate thoughtfulness in writing, but not to challenge a student with the task of explaining a difficult concept or situation to a reader who does not understand or is unacquainted with the matter is to ignore one of the primary requirements of the educated person.

4. Most freshman essays are planned along the inductive pattern. The writer begins at the beginning of his concept and gradually adds to it until finally, at the end, the point of the piece may emerge. The deductive pattern rarely occurs to him, and if it did, would probably be struck down by his instructor. Only recently I heard a colleague condemn a student for blurting out his main idea in the opening sentences.

So much for the obvious limitations of freshman English. Before turning to the virtues of tech writing, I must define my terms.

As all know, we labor in our field under the burden of a misleading name. The term "technical writing" is a far from accurate description of what we do, and turns away many would-be friends because of misunderstanding. Teachers of tech writing courses have regularly occupied a secondary place in the faculty hierarchy. In many instances, only the unfortunate or defenseless members of the staff have been assigned these courses. And the same has been true in Great Britain and on the Continent. Fortunately, this condition is fading; our courses and texts have been improving, we have attracted into the field some very able teachers, and the whole quality of our work has been on the upgrade. But we continue to be misunderstood.

The main reason for this unfortunate condition is the defining of types of writing by their subject matter, as evident in the organizations devoted to medical writing, business writing, science writing, and, more generally, technical writing. The ultimate in misinterpretation is the assumption that a teacher of tech writing teaches technical terminology. If defining tech writing by subject matter does not work, then what does?

I am convinced that the only precise definition of our field lies in specifying our approach. I can think of nothing that can be described as exclusively a technical subject. I think the only accurate view is that we approach our subject technically, and the subject can be anything—all the way from abstruse poetry to the mechanisms of hardware.

About Technical Writing

If this be true, then what is unique about technical writing? I prefer to think its uniqueness lies in the effort of the writer to achieve absolute precision, however impossible this may be. It differs from literature in that more than one interpretation is unacceptable. Literature, music, and the other arts evoke more than one response, sometimes contrary responses, and there is no objection to such richness. But technical writing must be as exact as the directions for firing a missile. A symphony may have different meanings, but a bugle call would be disastrous if it had more than one.

This definition has the merit of avoiding the confusion resulting from defining tech writing by its subject matter. The substance continues to be important, but serves only to specify the area in which the writing occurs. By this approach it becomes meaningful to refer to tech writing in medicine, tech writing in business, and tech writing in engineering. All have in common their precision; they are unique only in their material.

With this clarification in mind, let me return to the support of my thesis by naming the good things about tech writing.

1. Tech writing places the emphasis where it should be: on the reader rather than the writer. Freshman English instructors tend to grade a student's theme on the basis of what it reveals about the student's thinking; tech writing is graded on the basis of what the reader derives from it. The emphasis lies always on the clarity and validity of the communication.

2. The information flows in the correct direction: from knowledge to ignorance. The only reason for such writing is to acquaint someone with what he does not know or needs to know. The writer writes because he is the one who knows.

3. Tech writing is intellectually taxing. I am puzzled by the critics of tech writing courses who feel that the writing assignments are demeaning. On the contrary, they are extremely demanding. They require far more effort and care than does a casual discussion of one's personal reactions to a published piece regarding our permissive culture, which is the sort of thing often found in freshman essays.

The eminent Shakespearean scholar, G. B. Harrison, has testified to the fact that it is far more difficult to write satisfactory orders for a military operation than to discuss the psychoses of Hamlet, and he has done both. Precision is always achieved with great difficulty and requires the utmost discipline of thought and expression. If you have ever tried to write a set of procedures involving multiple simultaneous operations, you know what I mean. How labored are the statements of lawyers in their understandable effort to be explicit and precise. Nearer home, surely you have witnessed committees unable to agree on the precise meaning of the wording of their report. Usually they wind up, especially in English departments, by stripping away all precision so that the statement is meaningless enough to be acceptable to all parties.

4. And that brings us to another significant feature of tech writing. Its success and effectiveness are measurable, which is more than can be said about the average essay. The reactions to and within an essay are normally personal and subjective; the understanding of tech writing is mental. Its success as communication is quickly evident.

5. Finally, there is far greater likelihood that one can transfer to essay writing the lessons he learns in tech writing than the reverse. Good technical writing requires the exploitation of all the rhetorical devices of focus, logical partitioning and classification, and illuminating sequence, to name a few of the features appropriate to all writing.

In view, then, of these virtues of tech writing in contrast to the objectionable features of freshman English, you will understand why I contend that the trouble with tech writing is freshman English. When I try to teach tech writing to students who have had the conventional first year course, I run smack into all the characteristics that I have labeled as wrong about the course.

The worst feature is the student's insistence upon writing *up to his point* instead of *down from it*. I mean, he proceeds inductively rather than deductively. And this fault extends right on into the Ph.D. dissertation, in which the writer drags us through all the *how he did it's* and perhaps at the end will tell us what it's all about. The research for a dissertation is conducted inductively, but the arrangement should be reversed in the presentation of the material. We should be told the problem, the solution or answer, and then the supporting evidence. In this sequence, the reader can understand and evaluate the various steps in the investigation as he proceeds through the document. But he must know in advance what all the fuss is leading to. The worst fault I find in Ph.D. dissertations is the writer's insistence upon writing it the way he did it. Most dissertations could profit by taking a lesson from the technical report—for the dissertation, after all, is just that, whatever its subject matter.

In suggesting that tech writing replace freshman English as the required writing course, I must offer one modification. The course should be scheduled for the senior year after the student has accumulated a body of knowledge with which to deal. In our department we moved the course to the senior year a while back and are pleased with the results. It's a delight to read papers prepared by well-informed authors.

In conclusion, let me point to a possible irony ahead. Some years ago, decades now, colleges and universities pretty much abandoned rhetoric, especially in its applied form, in favor of linguistic studies. But those who needed rhetoric refused to accept this state of affairs. Professional schools like engineering and business and societies like STC and Medical Writers clung to the study and practice of rhetoric as a tool of communication, and in their hands it has flourished. Wouldn't it be ironical if the universities should now realize that this discipline was not such a bad thing after all and begin reinstituting it in their curricula, as some already are doing, only to discover that the discipline had endured and remained vigorous under the careful protection and nurture of our sometimes despised technical writing groups.

MERRILL D. WHITBURN

Against Substituting Technical Writing for Freshman English

Dr. Whitburn disagrees with Dr. Britton's proposal to substitute technical writing for freshman English. He feels that freshman English should continue to concern itself with general communications skills, while technical writing should involve the application of these skills to special kinds of communication. Merrill D. Whitburn is in the Department of English, Texas A & M University.

W. Earl Britton makes a rather controversial proposal in his article, "The Trouble with Technical Writing Is Freshman English," which appeared in the Spring 1974 issue of the *Journal of Technical Writing and Communication*. He points out the "objectionable features of freshman English" and "virtues of tech writing" in an effort to support his thesis that technical writing should replace freshman English in American universities. Although I sympathize with several of Britton's viewpoints, my own experiences lead me to question his thesis and the arguments he uses to support it. His criticisms of freshman English seem wide of the mark, and his view of technical writing is not generally held in the field.

Areas of Agreement

I sympathize wholeheartedly with Britton's view that technical writing has not been given its due on campuses across the country. Britton writes: "Teachers of tech writing courses have regularly occupied a secondary place in the faculty hierarchy. In many instances, only the unfortunate or defenseless members of the staff have been assigned these courses." [See previous article by W. Earl Britton.] He refers to "our sometimes despised technical writing groups." Teachers of technical writing know all too well that Britton is accurate here. But he is also accurate in his detection of a change: "Fortunately, this condition is fading; our courses and texts have been improving, we have attracted into the field some very able teachers, and the whole quality of our work has been on the upgrade." Undoubtedly, Britton is one of those who deserves credit for upgrading technical writing.

I also sympathize with the emphasis in Britton's essay on developing communications skills in the university. A recent survey of various industries to determine the requirements for a new doctor of engineering degree at Texas A & M University contained at least one resounding chorus: "Give us people with better speaking and writing skills." Anyone with experience in industry would be able to predict such a response. I recall a remark made by a former president of Western Electric, Paul A. Gorman, that sums up an attitude so many administrators have toward their companies: "Communications is my most important problem." Communications remains of central concern not only to industry but to all the professions.

Areas of Disagreement

But I cannot agree with Britton that the state of communications in this country will improve through the substitution of technical writing for freshman English. Britton seems to base his argument on the belief that freshman English is no longer emphasizing the development of communications skills. He charges that freshman English instructors put their emphasis "on thought quality and rarely upon communicative effectiveness." The resulting student essays too often emphasize "originality and something vaguely labeled literary quality." Although I, too, have heard of sections of freshman English where the emphasis has shifted from the development of communications skills to the development of expertise in literary analysis, most freshman English programs across the country do continue to emphasize communications. My experiences at three universities, an examination of freshman English texts, and journal articles in the field all support this belief.

I also find myself disagreeing with the more specific criticisms Britton levels at freshman English programs. Central to Britton's claim that freshman English instructors neglect communicative effectiveness is his belief that they fail to stress audience adaptation. One of the distinctions he makes between freshman English and technical writing is that "freshman English instructors tend to grade a student's theme on the basis of what it reveals about the student's thinking" while "tech writing is graded on the basis of what the reader derived from it." Although the wise freshman English instructor considers a student's thinking in his appraisal, he also comments on the rhetorical impact of a paper on the reader. A glance into almost any freshman rhetoric text will suggest the importance of audience adaptation in freshman English courses.

Britton complains that the flow of information in a freshman English class "proceeds from an ill-informed freshman to a well-informed instructor." Britton's observation is not wholly accurate. Most freshman English programs require research projects, and most students elect to write about subjects in which they become more knowledgeable than their instructors. But even if Britton's observation were accurate, there are advantages to the instructor's knowing more than the student. For instance, he can suggest arguments and support for arguments that the student may have neglected.

Britton's analysis of the way organization is taught in freshman English seems inaccurate. He writes: "Most freshman essays are planned along the inductive pattern. The writer begins at the beginning of his concept and gradually adds to it until finally, at the end, the point of the piece may emerge." The inductive pattern is sometimes effective in essays, but certainly Britton is wrong in suggesting that most freshman essays use it. If a student has learned his lessons well, the introduction of his essay will usually place his subject within a context, suggest the purpose of the essay, and state the organization of the essay, which often assumes an order of importance.

Building a Writing Course

Britton inquires whether it is realistic to build a writing course around the essay, "a form of composition that is rarely if ever pursued by the graduate in his professional life." But the student in freshman English is not primarily studying the essay but rather the principles of writing that underlie it, and these principles underlie all forms of communication. Most communicative tasks involve analysis, support, organization, style, and mechanics. The essay also involves these principles of writing, and the student exploring them in the essay can learn them and use them in all of the various communicative tasks he encounters in his later university and professional life.

Britton tries to make technical writing attractive as a substitute for freshman English by defining it in a way that differs from what is generally accepted in the field. Understandably, Britton seeks to show that the lessons learned in technical writing are applicable to all fields of writing, and he emphasizes those general aspects of technical writing like audience adaptation, the very aspects he claims are lacking in freshman English, to prove his point. But the portrait of technical writing that results does not accurately reflect the usual content of the course.

Britton suggests that the uniqueness of technical writing "lies in the effort of the writer to achieve absolute precision . . . ." He draws a distinction between technical writing and the arts: "It differs from literature in that more than one interpretation is unacceptable. Literature, music, and the other arts evoke more than one response, sometimes contrary responses, and there is no objection to such richness. But technical writing must be as exact as the directions for firing a missile." I like Britton's distinction between technical writing and art, but it cannot be used to differentiate technical writing from freshman English. Both courses encourage the writer to be precise.

Technical Writing as an Extension

Technical writing has traditionally been viewed as an extension of freshman English. In freshman English the student receives practice in all of the various rhetorical skills. If the student then takes technical writing, he learns to apply these skills to specific kinds of communication. A glance at the contents of any technical writing text is sufficient to suggest what some of these kinds of communication are: descriptions of mechanisms and processes, proposals, short and long reports, memorandums, and business letters. The basis for distinguishing between technical writing and freshman English, then, has not been precision but rather the kinds of communication involved. While freshman English concerns itself with general communications skills, technical writing involves an application of these skills to special kinds of communication.

I do not believe, then, that technical writing should be substituted for freshman English. Freshman English is useful in providing a general introduction to communications, and the course has been more successful than critics in recent years have been willing to allow. Technical writing, which has traditionally involved certain limited kinds of communication, could not be adapted to take the place of freshman English without becoming what it is intended to replace, a course in freshman English. Furthermore, Britton recommends that the technical writing course be taken in a student's senior year. Such a recommendation fails to take into account one of the primary functions of freshman English—developing the student's communications skills so that he can become more effective during his university years.

I look forward to working with my colleague Professor Britton in promoting technical writing across the country. I hope to work with him in creating an increased awareness of the need for improved communications skills. His criticisms are useful in reminding freshman English instructors to focus on the development of communications skills. I think, too, that the relationship between technical writing and freshman English should be much closer than it has been; an exchange of ideas between instructors of the two courses would undoubtedly be fruitful. But all of the various fields of communication should be promoted rather than one set against the other. Both freshman English and technical writing have important roles to play on the university campus.

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Technical Writing in Action

ANN A. LASTER AND NELL ANN PICKETT

Technical Writing as an Approach in Freshman Composition at Hinds Junior College

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The course in technical writing taught at Hinds Junior College, Raymond, Mississippi, where the authors both teach, is described. Emphasis in the course is placed on practical application of writing skills, with class lecture and theory of composition kept to a minimum.

Although English with its various categories has been included in the curriculum at Hinds Junior College since the college's founding in 1927, it was not until 1962 that Technical Writing established itself as a one-semester, sophomore-level course. Then for several years it was essentially a non-transfer, developmental, two-semester course. Subsequently in 1967 we as two members of the department, began work in earnest to develop a technical writing program that would provide a practical, freshman-level writing course for students in career education programs and that would provide six semester hours credit in composition for Hinds graduation requirements or for transfer to senior college. In the fall of 1972 with Hinds' formal inauguration of a multi-approach to freshman composition, Technical Writing I and II became one of thirteen approaches in English 1113–1123, Freshman Composition.

Hinds offers some twenty-five technically oriented curriculums, such as fire science, hotel-motel management, dental assisting, veterinarian's assisting, data processing, and nursing. These curriculums, which lead to an Associate in Applied Science degree, require a minimum of six hours of composition; generally students enrolled in these curriculums select Technical Writing.

Students enrolled in this approach have a marked diversity of age range, interests, and employment. Many are long-time employees with little or no formal training who have returned to college to enroll in a curriculum directly related to their occupation; others are students who are employed in jobs related to their curriculum choice, thereby receiving practical experience in addition to formal training. For example, persons enrolled in the Fire Science curriculum include members of the Jackson, Mississippi, Fire Department; students enrolled in Distribution and Marketing Technology are employed in various businesses in the Jackson Metropolitan Area.

Course content for Technical Writing was determined by a random study of area industries and service facilities (a large percent of Hinds Junior College students remain in the area) as well as by consultation with instructors of vocational and technical subjects. Currently first semester emphasizes why and how to write: instructions and process explanations, definitions, descriptions of mechanisms, analyses using classification and partition, and analyses using cause/effect; second semester includes direction and practice in writing: summaries, business letters, a library research paper, and reports. Each of these types of writing is presented as a unit of study with specific objectives and specific assignments.

Emphasis in Technical Writing is on practical application of writing skills, with class lecture and theory of composition kept to a minimum; for each writing assignment students fill in a plan sheet that requires stating the purpose for writing and the intended reader and listing specific information which is later organized into a composition. In the writing process, students are guided by individual conferences, comments on papers, and media. Then students revise and rewrite each assignment until it is satisfactory.

In the process of developing teaching-learning materials for Technical Writing at Hinds, we have published through Canfield Press (a division of Harper & Row), *Writing and Reading in Technical English* (1970), *Handbook for Student Writing* (1972), and *Writing for Occupational Education* (1974).

Many factors have influenced the growth and the quality of the technical writing program at Hinds. One factor is that the greatest increase in enrollment in the college has been in technically-oriented curriculums; therefore, the number of sections of Technical Writing has increased each semester. Also, the Jackson area is experiencing an unprecedented industrial growth, giving individuals an incentive to return to school to prepare for more gainful employment. Further, the technical writing program has received encouragement from all levels of the college administration. Other incentives have included participation in a Ford Foundation Program in Technical Education and a government grant for developing classroom materials for technical writing. The major factor, however, has been the enthusiasm and the dedication of the faculty involved in the development of the program. Instructors have been challenged by the community-based need for a technical writing program, by the interests of students enrolled in the program, by the lack of teaching-learning materials, by the practical emphasis of the program, and by the need to redefine higher education to legitimately include technical education.

Current plans are to refine existing units by correlating reading and writing skills and increasing oral presentation requirements. Also being planned is a new unit on the worker and humanities, a unit which will be media and fine arts oriented. To keep technical writing a practical program, instructors plan to continue to study writing needs of career education students at Hinds Junior College by visiting area industries and service facilities, by interviewing vocational-technical instructors and advisory craft committee members, by enrolling in vocational-technical courses, and by soliciting suggestions from former students who have attained gainful employment.

DAVID E. FEAR

Relevancy and Revision: An Approach to Teaching Technical Writing

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The course in technical communication which is taught at Valencia Community College, Orlando, Florida, where the author teaches in the Department of English, is discussed. This course minimizes lectures and stresses laboratory time, with much individual assistance given to students.

EH 157, Technical Communication, at Valencia Community College is a one-semester, three-credit-hour course required for the Associate in Science Degree (all terminal occupational programs). It is currently taken by approximately five hundred students annually (this number is increasing by roughly twenty percent yearly). These students represent some thirty-odd degree programs. Allied medical, public safety, and business-related programs furnish the largest numbers of students; but no single major contributes more than ten percent of the course enrollment, and all sections of the course are heterogeneous. A recent section shows a typical mix: four nursing, four industrial technology; three architectural drafting, three management, three fire technology, two law enforcement, two respiratory therapy; and one each of data processing, medical laboratory technology, industrial security, economics, and library science.

The heterogeneity extends to student age and work experience. The course is taken about equally by part-time evening students and full-time day students. Many students have been working in their major field for several years and are working on degrees primarily for job certification, whereas others are fresh from high school with no work experience of any sort. A large number of students have prior technical writing experience, particularly the retired military men. Several students have even worked as technical writers. At the other extreme are the sizable number of students who barely scraped through high school English courses.

College communication experience is also varied. Before entering EH 157, students are required to have successfully completed a one-semester composition course. Additionally, many students have also taken a second semester of transfer composition. Some students have also completed an introductory speech course. Others have taken a course in business communication. At the other extreme are the students who struggled through EH 151-51, a six-contact-hour, three-credit-hour composition course for students with writing difficulty.

Thus, the course described here has been specifically designed to allow students maximum freedom to work at their own levels without stifling the students with better skills or overwhelming those with lesser skills. Because of the diversity of writing needs of the student population, the course has also been arranged so that students may work on many different types of writing.

The course meets for one hundred and fifty minutes weekly for fifteen weeks, with individual sections meeting once, twice, or three times weekly. Roughly one-third of this time is devoted to lecture, discussion, and demonstration, with the remainder being spent in laboratory sessions. During these laboratories students prepare written and oral presentations with assistance from the instructor and occasionally from colleagues.

Each year that the course has been offered, the ratio of lecture to laboratory time has decreased, with students receiving proportionally more individual assistance. Lectures are now limited only to those aspects of the course content that have proved to be bothersome to the majority of students. Otherwise, students can use the required textbook, supplementary texts furnished by the instructor, and model pieces of writing furnished by the instructor and often by students themselves. Then individual difficulties can be handled during laboratory sessions. Extensive use is made of models. Many students feel the need to visualize a particular writing assignment. Thus showing them several models often seems to help more than further explanation would. Several models of each type are gathered from the text, other texts, the instructor, or other students. When sufficient ready-made models are not available, hypothetical models are constructed. Students then do not need to rely on one model, which probably would not fit their material very closely anyway. Even so, the instructor must constantly help students to use models as just that—models showing how someone else has handled a particular writing situation—not as rigid structures into which a student must force his material

Each student is expected to complete six units of work: general skills, technical letters, formal reports, informal reports, illustrations, and oral reports. The exact number of assignments varies considerably, with a norm of twenty. Many assignments can be completed in a few minutes each, but others, such as the formal report and preparation of an individual oral presentation, require many hours, both in class and out of class.

All assignments are submitted for instructor evaluation but may be revised if a student is dissatisfied with his grade. Grading is subjective, but the allowance for revision permits a rather demanding standard. To be given an "A" or even a "B+", a piece of work must be usable. It should be effective enough that it could actually be submitted or mailed if done on the job. Revision is naturally very common. Nearly all students revise some work, some students revise nearly all work, and a few students revise some pieces several times. A few, of course, do excellent work and need do very little revision; a few others are satisfied with mediocre marks and revise nothing.

Evaluation of a given piece of work is made on a combination of factors, but no specific formula is used. Rather each paper is read with the question in mind "How effective would this be if it were actually used?" Structure and substance are both important, with mechanics strictly a negative factor. In fact, little structured class time is devoted to usage, spelling, or punctuation. Students are, of course, helped with these matters during laboratory sessions. They are also given further assistance outside of class and are furnished handbooks and other materials to work with on their own.

The term begins with two introductory lectures preceding the unit on general skills. In addition to the standard course overview, these two lectures present the four qualities of effective writing that are stressed throughout the course: reader adaptation, level of technicality, clarity, and conciseness. Throughout the term, students are conditioned to the belief that "The reader is king; give him what he wants." Acceptance of this belief entails far more than does the traditional notion of reader analysis. Students are shown that the people for whom they will be doing much of their writing after graduation often violate what composition and technical writing instructors call the "principles of good writing." Techniques for which a student is praised in college might well bring him harsh criticism in business and industry. So students are warned always to temper their notion of effective writing by considering the demands of their specific positions. A corollary to this somewhat cynical view is the belief that there is probably not any one "best way" to do any specific type of technical communication. Organizations often like to do things in their own ways, and the student is so advised.

A more conventional view of reader analysis is presented in the statement "Always pick the appropriate level of technicality." Students are shown how almost any piece of communication can be presented at various levels of technicality; then they are shown how to judge a potential reader's level. They are usually given an exercise of some sort requiring them to define several possible readers and to develop appropriate versions of a document for each. Then throughout the course they are regularly cautioned to always determine the appropriate level for anything they write.

The final two guiding principles, clarity and conciseness, are treated conventionally. Clarity is shown to be almost a sine qua non, with conciseness following directly. Traditional concepts such as objectivity, avoidance of jargon, and coherence are stressed. Perhaps the only unusual aspect of this part of the course is that slightly less stress is placed on total objectivity and on absolute conciseness than is often done. Students are encouraged to write clearly, effectively, and concisely without necessarily removing all of the "blood" from their prose.

Six assignments are suggested in this general skills unit:

1. Definitions—one extended and two working
2. Process analysis
3. Set of instructions
4. Description of a tool or a piece of appara[illegible]
5. Informational abstract (summary)
6. Descriptive abstract (abstract) on the same subject

This is followed by a technical-letter unit. Two lectures precede the laboratory sessions. First, some basic philosophical notions of letter writing are introduced. Tone is especially emphasized. Next, an entire fifty-minute period (often more) is spent discussing and exemplifying the art of resume writing. Students are guaranteed that they will at least get their money's worth from their tuition fees if they develop a first-rate resume, then file it for future updating and use. Four specific assignments are then made:

1. Resume with letter of application
2. Letter of inquiry
3. Claim letter
4. Response to claim

The most complex assignment of the course is next introduced: the formal report. Although the assignment is termed "formal report" and many students write conventional reports, students are really required only to do some sort of major technical writing project. Whenever possible students do projects related to their jobs or to other courses. In fact, arrangements with several technical-occupational instructors permit students to use projects for both Technical Communication and one of their major courses. Several occupational programs now require all student reports to be done using the format and approach taught in Technical Communication. Three, and sometimes four, fifty-minute periods are spent discussing and exemplifying formal reports. Various types of reports are presented, formats are discussed, and tones and points of view are illustrated. Many previous student reports are then shown and discussed. The projects are generally due one week before the end of the term. Most of the work is done outside of class, but students are encouraged to discuss their work in any laboratory period during the remainder of the term. These projects may, like all other assignments, be revised, but they must be handed in at least a week before the deadline to allow time for the extra evaluation.

This generally brings a class to midterm, the second half then beginning with a brief unit on illustration. Prior to actually starting the unit, most students feel quite threatened by the knowledge that they are going to be asked to actually construct illustrations, to actually draw. However, by the time the unit has been completed, these same students usually agree that it is the easiest assignment of the term, and many find it to be the most enjoyable. Two lecture-demonstration periods focus on when to and when not to use illustrations, on how to fit them into a text, and on which type to use where. Then students are asked to construct the following six:

1. Table (matrix of at least twenty-four)
2. Line graph

3. Bar graph
4. Circle graph
5. Organizational chart
6. Flow chart

Finally, students are shown how these six illustrations and simple line drawings can be used to convey almost anything they are likely to need to convey. Of course, students with more highly developed drawing skills are shown how to use their work effectively in technical texts.

Illustrations are followed by informal reports, usually the longest unit of the course. Two introductory lectures are given; then a minimum of five informal reports are developed in laboratory sessions:

1. Progress report
2. Status report
3. Trouble report
4. Travel report
5. Proposal

The progress report and proposal are the only assignments given in which a student has no choice of subject. He is allowed to select his own subject, usually from his major field, for all other assignments. The progress report is written directly to the instructor, informing him of the student's progress in completing the major report assignment. The proposal, the final written assignment of the term, is also written directly to the instructor. Each student must propose to make a ten- to twelve-minute informative presentation to the class on a subject of his choice.

Class time is also devoted to the discussion o. form completion, preparation, and utilization. Students often bring in forms from their work and evaluate or revise them during laboratory periods. Some students even develop forms for their status, trouble, or travel reports.

The final several weeks of the term are spent working on oral reporting. Two fifty-minute lectures are given: one surveys the oral communication needs of technical people and examines some typical group speaking situations; the second focuses on giving individual presentations before groups. If time permits, students are then asked to participate in some sort of group speaking simulation such as an interview or a committee meeting. In larger classes, which naturally require more time for individual presentations, this group work must often be omitted. The last activity in the course is the final oral presentation. Each student gives the presentation he has proposed several days before.

The detailed schedule of suggested assignments just discussed is suggestive, not restrictive. In fact, few students complete every assignment exactly as listed. Students are encouraged and helped to develop their own assignments. Only the proposal and progress report cannot be substituted for, although most students are encouraged to do the general skills unit. Anytime a student wishes to make a substitution or to do some unscheduled work, he merely informs the instructor, and permission is almost automatic. In this way, students who already have writing responsibilities at work and those who know of specific writing needs in their prospective professions may make the course very nearly "on the job training."

Most students do submit a packet of letters, a set of illustrations, some informal reports, and a major project. However, students regularly submit some type of letter not assigned instead of one of those listed. Some students wish to make several types of tables or flow charts and are thus excused from some other illustration. But the greatest variety of assignments occurs in the informal-report unit. A typical laboratory period may find students working on insurance reports, lab analysis reports, operational procedures, job descriptions and union bylaws, with only two or three actually working on the assigned travel report.

Students who do not yet know the writing demands of their chosen field are often helped by other students in the same major field or by major-area instructors.

Even those students who do none of the specialized assignments need not feel the course to be irrelevant. The scheduled assignments all ask the student to write about his major field. So he will be defining terms from his major field, preparing a resume that he may well use in seeking his first job, and reporting hypothetical accidents he hopes will never occur.

The student who is a complete novice in his field, who might just now be taking his first course in his major, or who has not yet decided on a major is the most difficult to help. Occasionally, we are unable to find any subject related to a student's major and he must write about something else. In such cases we usually locate hobbies, jobs, or unrelated college classes that will furnish suitable subjects.

Ideally, to benefit most from the course, a student should have at least an introductory-level understanding of his major area, because even if he enjoys writing about hobbies, jobs or other college courses, he will not get quite the same kind of training that a classmate who had already completed two or three courses in his major field would.

Fortunately, as instructors teach the course for a few semesters, they begin learning much about both subjects and special writing needs within major fields. This fact, coupled with the previously mentioned suggestions from subject-area faculty and from other students, alleviates the problem considerably. Area employers are also a good source of information. Of further help has been the suggestion made to counselors, instructors, and prospective students that taking the course be deferred until a student has taken at least the introductory courses in his major field.

A related problem in teaching the course is the enormous amount of supplementary material and supplementary knowledge needed by the instructor. The first few times that a course is taught this way, the instructor may well feel helpless when asked by students to help them improve their ability to write things that he has never written himself and possibly has not even heard of. But each of the sources mentioned previously will help, and his own experience will soon do the rest. After a year or two he will have accumulated a large file of material, and he will have seen most special writing types that he is likely to see. Most importantly, he will have come to realize that basics such as clarity, conciseness, and reader adaptation offer a sound basis for developing criteria to criticize almost any kind of technical writing.

One disadvantage of this approach can never to totally overcome: it demands a great deal of the instructor's time. Certainly he will gradually need less time for accumulating materials and learning himself, but simply evaluating some twenty assignments from each student, many of them submitted several times, is going to require a great deal of time. There are two changes recently made in methodology that do help a bit. Increasing laboratory time in class lets the instructor do more of his criticism then, rather than after the assignment is submitted. This is especially helpful in getting students to do high quality work on first submission, thus saving revision time for the student and evaluating time for the instructor. A second helpful change is to require students to work on assignments in laboratory sessions if they want to have the privilege of revising.

This has sharply decreased the incidence of mediocre first submissions, done with the knowledge that the instructor would point out all of the weakness, which could then be easily revised. It has also cut down on late assignments and has improved attendance.

Although the course is obviously very demanding of students, their response has been quite favorable. Formal student evaluations are consistently higher than those for composition courses. Informally, comments such as "the most useful English course I've ever had" are becoming common.

JOHN A. WALTER

Confessions of a Teacher of Technical Writing

A seasoned technical writing teacher shares his experiences and expresses his convictions regarding technical writing, convictions arrived at through an extensive study of technical and scientific documents as well as through years of teaching. John A. Walter is Associate Chairman of the Department of English, University of Texas, Austin.

What can a teacher who has taught technical writing for more than twenty-five years say to his younger colleagues that will help them help students of engineering and science write better? Is it possible for me to distill something pure and undefiled from all those years of experience that I can convey to young teachers just starting out to teach technical writing?

I shall try to share with you some of the results of my own experience in teaching technical writing and I ask you to be tolerant of me as I reminisce about more than a quarter of a century. Before I mumble off into silence, I hope to tell you what I have found it possible to try to do in a one-semester, introductory course in technical writing.

Like many of you, I suspect, I began my teaching of technical writing without any special preparation and certainly without experience. After I accepted my first college teaching position, I was simply told by the chairman that I would teach two sections of technical writing (not to mention three sections of freshman English!). Given a textbook, I frantically began my "preparation," which consisted largely of trying to keep ahead of my students. (That text I still remember well: *Practical Forms in Exposition* by Richardson, Guthrie, Becklund, and Haga, published by Macmillan.) Along with careful study of the text, I got hold of additional texts on technical writing as speedily as I could; I wanted to learn something to supplement the text which would permit me to do something in class other than parrot the text. Well, that was a long time ago, and I prefer not to think about the quality of instruction I offered to my students. But something significant did occur during those early semesters: I became intensely interested in the subject and devoted a great deal of time to careful study of corollary texts, not to mention a good many books dealing with science and engineering in general. I began reading the *Scientific American* and the *Scientific Monthly;* Azimov, Jeans, and Eddington became familiar authors to me. My objective in this reading was not to become expert in any scientific field (clearly an absurd objective), but I did want to acquire enough information so that I could use relevant illustrations and examples in class. A secondary aim was to try to win the confidence of my students; I did not, in other words, want to be identified in their minds as a dilettante *litteratus*. I believe this reading was useful—in any case, it was interesting.

I'll not bore you with all the details of a painful process of self-training. I did read a lot of books, every one I could find on the subject, including T. A. Rickard's *Guide to Technical Writing* published in 1908. I began to be more critical of texts; I began to have opinions of my own about the best way to deal with specific presentational forms, opinions about their formats and about useful communication strategies. I began to notice whether there was any correlation between what the texts said and what I observed in technical articles and books (often very little). I began to want to examine actual engineering and scientific reports, brochures, proposals, etc. to see what they had in common, to see what sorts of exposition writers were obliged to use—in other words, I wanted to see for myself, rather than accept uncritically the words of the text authors I read.

This sort of thinking led, in time, to an extensive collection of documents from industry and government agencies. After World War II (I had to take some time off to serve as a communications officer in the Navy), Gordon Mills and I were fortunate enough to get some three hundred companies to cooperate with us in providing answers to a large number of questions about the place of technical writing in their organizations and in providing us with copies of a wide variety of technical and scientific documents. We read hundreds of these documents to find out, simply, what was there. Our work led, in time, to our publishing a bulletin dealing with the theory of technical writing (published as Circular No. 22 by the Bureau of Engineering Research at the University of Texas some twenty years ago).

I haven't space here for even a superficial account of the results of our study, but I can say that our reading, both of texts and scientific and technical literature, led us to a number of convictions:

(1) Scientists and engineers are concerned, when they write, with presenting information to a specific body of readers for a specific purpose. It matters little to them that the result may be called a periodic, progress, recommendation, research, interim, investigative, test, feasibility, short or long report—or a handbook or manual; their work has brought them knowledge—and judgments—of a specific subject, and their task is to convey that information, or some part of it, to those who want and need it. The experience of writing is one of formulating sentences, paragraphs, sections, etc. into a satisfactory whole. And the demands made of them by their readers, aside from accuracy and completeness of the information, are that they be clear, concise, and, if possible, interesting. In short, we became convinced that the rhetorical approach makes more sense than the "types" approach. In those books which devoted entire chapters to a variety of types of report, we found that the authors had to deal with essentially the same writing problems in discussing each type. Let me put it another way: what essential difference is there between an examination report and a recommendation report? Obviously, the latter contains recommendations—and that's about the only difference. In other respects the two could be identical. Regardless of the type of presentation, a writer must first collect information, then he must organize it, and finally he must present it, hopefully in a manner and style that will make the presentation successful. These are activities common to all kinds of presentational forms. We concluded, then, that only those forms (like the progress report, for example) that are unique in some organizational or stylistic way deserve to be singled out for chapter-length discussion. We also concluded that a technical writer is likely to have to define, to explain processes, to describe things, to classify related information, and to explain its significance regardless of the name that may be given to the finished document.

(2) We also became convinced that the only really sensible criteria for judging quality in technical presentations are pragmatic: does

the report, article, manual, or whatever, work for its readers? We came to believe in the primacy of what we call the communication situation, the complex of factors which define the relationship between writer and reader(s). A corollary of this was recognition that the typical classroom situation is highly artificial: there are some twenty-five students to write for one reader, the teacher; moreover, the reader is presumed to be expert already—he doesn't really *need* the information being presented to him, and certainly it is presumed that he can read without the author providing him with the background, the amplifications, the explanations of terms, etc. that may be called for by the "communication situation" in industry, government, or commercial publication. Once the student has graduated, however, *he* becomes the expert when he writes a report, a memorandum, an article; his readers are those who want or need to know what he knows. Recognition of all this, simple as it is, alters one's approach in the effort to teach effective writing. Or so it seems to me.

(3) Like architects, we became convinced that form (format, if you prefer) follows function. Moreover, we came to feel that no single format is sacred or necessarily superior to all others. We would concede that there is something to be said for aesthetics and that surely there is merit in consistency—at least throughout a single presentation. This does not mean we ignore form; it does mean that we try to see it in sensible perspective. Documentation (footnotes, bibliographical forms, for instance) may have to be provided for, say, a research report and the documentational forms may be specified by a style manual, or whatever; what is really important, though, is that certain information about a source be provided so that that source is fully identified and could be secured, if needed, by the reader. The details (whether presented in accord with the G.P.O. Style Manual, Chicago *Manual of Style*, or any one of the dozens of manuals of style that exist) are relatively unimportant.

(4) Still another conviction is that writing assignments should be as practical as possible and that their subjects should engage the interest of the students. I have observed that engineers and scientists in professional life write research reports based on library research rarely, but I believe that such an assignment makes good sense in school, and that it is more realistic than having students attempt to simulate the kinds of documents that they are much more likely to have to write once they have completed their professional training. After all, it is scarcely reasonable to ask students to undertake original research and report on it. I believe the skills required in

the preparation of a library research paper will prove useful to the professional scientist and engineer, no matter what kind of report he finds himself obliged to write. Assignments in other forms are proper, of course, but I believe they should be designed to make a contribution to the effort required in the production of a major performance—the research paper.

I have a good many additional convictions about teaching technical writing, but the ones I've mentioned should suffice to explain why I organize an introductory course as I do. So now let me restate what my aims in the course are and then go on to sketch how I apportion the time.

As the foregoing has made clear, I hope, a basic course in technical writing should aim to guide students toward the acquisition of skill in practical communication; specifically, they would acquire facility in writing business letters, various kinds of basic types of exposition peculiarly pertinent to engineering and scientific reports, some common kinds of reports, and a long library research report. More generally, and accompanying the above, I try to familiarize the students with the requirements of acceptable style in technical writing, with problems of organization, with problems of writing introductions, conclusions, and transitions, with standards of acceptable format, with some elementary graphic aids, and with the skills involved in finding and using published information. If time permits, I also try to give students some experience in making oral reports (usually on some phase of the research they are doing for a long paper).

Since many of the communications young technical people have to write are in letter or memorandum form, I begin my course with letters and memoranda. Devoting some half-dozen meetings to this subject, we discuss the form, style, and organizational requirements of this genre, and I require them to write letters of inquiry and reply, transmittal, and application as a minimum.

After the initial two-week period devoted to letters, I introduce the long research project, with the immediate objective of having students submit a proposal of a topic for research that I can either approve, modify, or disapprove. To this end, I spend quite a lot of time on the importance of selecting a topic that can be intelligently handled in a four- or five-thousand-word report. I stress the necessity of limiting the subject sufficiently so that the research can be reasonably complete and that the finished report can be a full and informative treatment of the subject. Most of the information for the report must be secured from published materials, but I also allow for the use of experience, industrial literature, and data gained through observation and interviews. Since the paper is based on library research, primarily, I devote whatever time is needed to discussing of the use of the library resources, note-taking, documentation and bibliographical forms, etc. All of this culminates in my requiring each student to submit a proposed topic, complete with a tentative bibliography of sources he has been able to locate. If the student has done his work well, I note my approval of his topic on the paper when I return it and he can then devote time, at his own choosing, to doing the necessary reading and note-taking in preparation for writing a draft of his paper later on in the semester (I usually require that the paper be turned in to me at least a couple of weeks before the end of the term). If the student's proposal is not completely satisfactory, I may ask him to resubmit his proposal, with appropriate changes or modifications, or, in severe cases, I may ask him to confer with me before resubmitting a proposed topic. (Common problems, as you probably know, are much too broad topics and inadequate bibliographies.) An incidental advantage to requiring a written proposal of a topic is that the teacher can insure that students will not write on subjects beyond the teacher's ability to understand. I have found that many young teachers of technical writing are bothered by a fear that students will write on subjects they know nothing about, subjects of such advanced technicality that the teacher cannot know whether the student knows what he is writing about or not. The written proposal can help insure that this will not happen; after all, it is perfectly legitimate—and good training for the student—to require that the treatment of the subject be perfectly clear and understandable to the reader (the teacher, in this case).

Discussion of the research paper and related topics usually takes me about two weeks (three one-hour meetings per week).

With the above chore out of the way, I then devote about five or six class periods to organization and style. Deserving as it is of extended discussion, I do not have time here to go into detail about my approach to organization, except to mention that I stress that the formal outline is the outcome of a lot of work and thinking, that it is merely the written record of the whole process of making decisions about the best order in which to present information already secured. As for style, I can devote my time to those aspects of style which are special in technical writing. My students have had a year-long course in composition and rhetoric as a prerequisite, so I do not have to spend much time on grammar and usage, fortunately. I accompany my treatment of organization and style with a number of exercises, both in class and out.

Following organization and style, I then devote a number of weeks, usually at least four and often five, to basic types of exposition: definition, process, description, and analysis. Papers are required for each of these expository types. Since these expository types constitute the heart of a course following the rhetorical approach, this part of my course occupies the largest segment of time. I will not detail what I try to cover in class, but as you are doubtless well aware, a number of textbooks devote chapters to each of the basic expository types I have mentioned (including the text G. H. Mills and I have written: *Technical Writing).*

The foregoing takes us well into the semester so that by the time we have completed this work, it's time to return to the research paper and deal with its form and layout; the use of illustrations and graphic aids in it; the special problems of introductions, transitions, and conclusions; the problems and techniques of revising and polishing a final draft. I should add that, some time before the research paper is due, I ask students to submit a progress report detailing how far along they have come with their work. It's not a bad idea, as a matter of fact, to have several brief progress reports throughout the semester: it helps stimulate students to do the work before the end of the semester forces them into the traditional last-minute crash program.

And that's about it. If time allows, I spend the last two weeks or so (during which I am grading the research papers) having my students make oral reports on some aspect of their research. I try to schedule these so there can be time enough for students to ask questions of the speaker. Frankly, it's one way of encouraging students to master their research materials.

Now it's time to retreat into silence. I do feel compelled to say that I've only taught the course for twenty-five years or so and there are, therefore, a good many problems I haven't solved yet. I am trying to say, quite honestly, that I have no absolute conviction that the course I teach is the best that can be done. It's one way, and a way that works pretty well. But there are others, and I, for one, would be glad to hear how other teachers have dealt with the problems of teaching a basic course in technical writing.

HERMAN A. ESTRIN

An Engineering Report Writing Course That Really Works

A description of how a course in report writing is conducted is provided; and testimony of its practical value, given by students, graduates, and faculty colleagues, is presented. Herman A. Estrin is in the Department of Humanities, New Jersey Institute of Technology.

> Speaking of report writing, I thought you might like to know how valuable I feel the report-writing course was and how fortunate I was to be able to take it . . . I have heard many engineers comment as to how much they dislike writing any type of report and how sorry they were that they hadn't taken such a course.
>
> I will go so far as to say that of all the non-technical courses that I took at college the one of greatest importance to me and to my job is Report Writing!

This excerpt is from an unsolicited letter from an alumnus who took the required course for seniors in the Civil Engineering Department entitled "Engineering Report Writing." The course meets three hours a week for one semester.

To learn the techniques of report writing, students were assigned chapters in Ulman and Gould's *Technical Reporting Revised.* To supplement these discussions, the instructor assigned readings in his anthology *Technical and Professional Writing* (Harcourt, Brace and World). In this way, students read articles on technical writing which were expertly and interestingly written by engineers and scientists. From these readings students wrote a paper on "How Engineers Can Improve the Style of Their Writing."

Another project was to have students read the writings of the technical writers of the past. This assignment is based on Walter J. Miller's article "What Can the Technical Writer of the Past Teach the Technical Writer of Today," *IRE Transactions on Engineering Writing and Speech*, December, 1961. Such works as Agricola's "The Education of a Mining Engineer," Archimedes' "An Engineer Defends His City," Aristotle's "The Egg and The Chick," Biringuccio's "DeLa Pirotechnia," and Herodotus' "Flood Control" proved to the students that technical and scientific writing need not be dull and boring but can be interesting, informative, and picturesque.

From a two-page bibliography "Masterpieces of Science and Engineering Writing" students read a minimum of ten selections from Homer to Hoover and prepared written reports concerning such facets as biographical data, a description of content, the reasons why the selection is considered a "masterpiece," and the relevance of this selection to engineering problems in our modern society. In addition, each student prepared his own annotated bibliography on engineering and scientific writing. Students were encouraged to go to the library; to use the various indexes; to become acquainted with the diverse professional magazines; and to read articles that concerned style, semantics, editing, audience level, illustrations, and composition. This assignment stressed the importance of writing succinct, intelligent summaries and bibliographic data. By the number of science and engineering magazines which published articles on the techniques and the improvement of technical writing, students learned that effective writing in the profession of engineering is both necessary and important.

Editing a technical report gives the student an objectivity to technical writing. It seems that a student cannot edit his own work because he is subjective about his own writing. He cannot be objective about finding his own mistakes in writing, language, and format. In addition, editing gives the report an appropriate audience and a direction—a fulfillment of the purpose of writing. The student editors must read these reports intensively and minutely. To show an overview of report writing by other engineering students and to give students experiences in editing, the instructor required each student to edit at least three reports written by students in other departments—electrical, chemical, mechanical, and industrial. Most of the reports that were edited, students noted, showed an inability to state relevant points with clarity. These editors agreed that many errors were made on the format of the report because of a lack of proper training in the techniques of report writing and because of the knowledge that the instructor would read the report only for technical content. Comments made by students after they edited a report are as follows:

> This report lacked good sentence structure and an effective vocabulary. The student wrote immature sentences and misspelled many words. His style was too choppy because he used too many one-sentence paragraphs.
>
> The student could have improved this report if he used captions, figures, and indented table numbers. His illustrations did not clarify his text and included irrelevant details. He overused the pronoun this and the expressions it is important and it is interesting.
>
> This report was well organized and logically presented. The sentences were varied and well constructed. The paragraphs were fully developed with specific details. The illustrations were carefully drawn and accurately numbered. This student wrote interestingly and correctly.

The preparation of a final report submitted to the Civil Engineering Department served as the culmination of the course. Class discussions covered the important techniques of report writing, especially the use of the outline, footnotes, letter of transmittal, bibliography, and other details relating to the format of the report. In addition, students were assigned pertinent selections in the anthology to enable them to become more mature in their style of writing and their fluency of effective expression. Some class time was spent in the library where the instructor was available for consultation concerning library research, methods, and resources. The Civil Engineering Department instructors aided the students to select appropriate subjects for research. Students submitted for approval their tentative outlines to the instructors of both departments. Some typical report titles are as follows: "The Control of Erosion on the New Jersey Coast," "The Design of Storm Water Drains," "Pollution in New York Harbor," "Reservoir Silting," "The St. Lawrence Seaway," "Sea Level Canal at Panama." In this milieu, students were motivated in writing a report because the assignment was meaningful, purposive, and relevant. Also, at this point in their education they have had an extensive knowledge of their subject content in civil engineering, they are more knowledgeable in their use of library resources, and they realize the importance of effective expression and communication in writing. For these reasons the majority of the reports were excellently written both in content and in format. Each student received two grades on the report—one for the subject in civil engineering and one for English.

An instructor of the Civil Engineering Department said the following after he read the required reports:

> It was a pleasure to read students' reports that were logically organized, intelligently prepared, and accurately written. As a result, I was able to read the report more easily and to make significant comments about the content because I was not bogged down with misspelled words, ungrammatical constructions, and poor sentence structure.

Another stated:

> These reports have a "professional air" about them. They are easily readable, correctly documented, and graphically illustrated. The style of the majority of these reports is mature.

A third instructor commented:

> Since the seniors have been taking the engineering writing course, I look forward to the reading of their reports. They are literate, relevant, and logical. Students show a mastery in writing, in research, and in the presentation of scientific and technical materials.

In the final phase of the course, students are encouraged to publish their own articles. Throughout the semester the various course assignments require students to read the many professional magazines and to familiarize themselves with the style, content, and format of the published articles. Also, the instructor discusses the advantages of writing for publication, namely, the pleasant satisfaction of accomplishment, the recognition by management and by one's associates, the greater possibility of advancement in one's position, the increase in one's professional status and prestige, and the broadening of the knowledge and the perception of the field in which he writes.

As to the specific preparation of an article for publication, students are taught to analyze the various professional articles. They discuss the content, format, and length of these articles. They study the many kinds of opening and of concluding sentences and paragraphs; the logical organization of the material; the presentation of illustrations and graphs and the derivations of equations; and the style, the vocabulary, and the grammar. The instructor stresses the fact that the contents of the article should contain timely, important information of immediate practical usefulness and should be of wide interest to many engineers. Class discussions concern the handling of manuscripts by the editor—the review of the manuscript, the editing of the article, the submitting of the revised manuscript to the author for approval, the copyrights, the payment for articles, and the ordering of reprints.

A student whose article was published in a leading engineering journal said:

> To see my article as the lead article of this magazine was one of the great thrills in my life. I worked hard in preparing the manuscript, but the joy of seeing it in print, the complimentary comments that I received from my classmates and from my instructors, and the satisfaction of a job well done compensated for the many hours I spent in preparing the manuscript.

At the conclusion of the course, students wrote the following evaluations concerning their reactions to the semester's work:

> As one who found it difficult to bring myself around to writing anything, I found the assignments forcefully stimulated me into the writing process. The abstracts, bibliographical cards, and the reviews of masterpieces were good devices for encouraging the writer to write with quality for short spurts. All of the assignments were fine warmup exercises for the final report.
>
> I feel that the course was very effectively presented. I gained a store of knowledge and have gained confidence in my writing.
>
> Since taking this course, I have become very critical and aware of improving my writing. I also can detect poor style of writing in the newspapers. Before I took this course, it was difficult for me to write anything, but now I see that it can be done. You have instilled a confidence in me to write accurately and maturely.
>
> This course has taught me to write more effectively and to have confidence in my writing. In fact, as a result of this new faith in my ability to write, I have submitted a manuscript for publication and received a letter stating that it will be published within the next six months.

6

Evaluating Technical Writing

RICHARD M. DAVIS

Experimental Research in the Effectiveness of Technical Writing

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An experimental method is suggested for deriving objective evidence of the effect, if any, of given elements in the content, organization, and presentation of a written technical message upon the effectiveness of that message. Richard M. Davis is with the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

When you write something and your supervisor or editor suggests a change to make it "better" or "more effective" how can either of you prove that your version is better or, for that matter, that there is any real difference at all in the effectiveness of the two? Generally, you can't.

Handbooks, dictionaries, and texts are available to guide us on many matters of mechanics, usage, spelling, and grammar. Local and more general conventions provide varying degrees of preference or authority on format, layout, symbols, abbreviations, and sometimes on organization and general content. Readability formulas may be used as touchstones to indicate the level of general education necessary to read a passage easily—though just how they can or should be applied in technical writing is something of a question. But when we look for objective evidence that one selection of information, one sequence of presentation, or one way of phrasing a fact or an idea is more effective than another in a given situation, we cannot find it. And that is just what most arguments between authors, editors, and supervisors are about.

When an engineer lays out a circuit or designs a device to fit a given application, he can usually predict with reasonable confidence how it will perform under varying conditions. Parts and subassemblies are designed and built to fill their individual functions. When assembled they work together to accomplish the overall function. And if they do not quite perform as intended, the engineer can generally modify them so that they will. That is what makes him an engineer, and that is what he is paid to do.

Uniform standards, Maxwell's equations, conversion tables, material data, Kirchoff's Laws, and other tested and proven information guide the engineer in his design; even when he is working on relatively uncharted ground he is able to predict the effect of a given current, calculate shrinkage, or anticipate the behavior of electrons. Certainly there is ample room for imagination in approaching an assignment and for ingenuity in solving the problems that arise, but a body of technical information based upon objective evidence is available for use as needed.

The report that the engineer must write to explain his work is another matter. There are scores of books, pamphlets, and brochures on technical writing—and dozens more are produced each year. They discuss many aspects of technical writing at considerable length. But I should like to note two very significant differences between the guidelines available for actual engineering work and those available to tell the engineer how to write about it.

First, texts on report writing are based largely on logic (what it seems ought to be effective) and tradition (what others have said is effective) with a greater or lesser tip of the author's hat in the direction of actual practice in one or another or even several fields. Such texts are not based upon forms, structures, or practices which have been derived, tested, and found to be effective by objective means.

Second, while these texts recommend general forms of organization and kinds of content for sundry written communications, the precepts usually become more vague as the potential technical writer's job becomes more specific. The writer is told that a suggested form will usually apply but that it must be tailored to fit the immediate situation. Suggested elements of the immediate situation often include the position of the intended reader, his knowledge of the general or the specific subject of the communication, what he needs to know about the subject matter, and similar considerations. But just how the tailoring is to be done when these are defined is usually left to the potential author. This is the direct opposite of the condition in most common engineering projects. Here, as the elements of a problem become more exactly defined, the specific action to be taken—the formula or procedure to be used and what can be expected from it—is more precisely known.

By all of this I am not suggesting that the authors of works on technical writing are at fault for the uneasy generality of their directions about the most effective way in which to write a specific communication for a specific audience. They aren't. Every situation in which a technical communication is to be written is different—to a greater or lesser extent—from every other situation in which one is to be written. Practical considerations limit the amount of material that the author can cover and the depth to which he can cover it. But, beyond this, there simply is not much objective evidence to indicate the content, organization, or presentation that should be used to communicate a given subject to a known audience in a particular situation.

In this paper, an experimental approach to the development of this kind of information will be described, and the results of three experiments using it will be discussed briefly. Although it is not possible to present full detail here, the discussion should be sufficient to provide a general understanding of the approach and the procedures involved. Readers interested in more complete information will find it in the reports listed at the end of the paper.

Communications Situation

The experimental approach is based upon a simplified view of a situation in which a written communication might be produced. The essential elements are the same as in other communication situations. For some reason, someone wants to tell someone else something about a given subject. Assuming that the medium by which the message will be transmitted is written English, there must be an author or source, a purpose, a subject, and an intended audience. The possible conditions of each of these elements defy specification, and the possible relationships between them are infinite. In no two situations are the conditions of these elements or the relationships between them exactly the same.

In practice, the author appraises the immediate situation and develops his message to fit his analysis of the case in hand. He draws upon his education, experience, and whatever ability he may have in the particular variety of authorship required. He considers the subject, his purpose, his intended reader, and whatever local or universal forms and traditions may seem to apply. Then he writes and presents his message as seems to him most effective for the attainment of his purposes.

Experimental Approach

When the communication situation is viewed in this way, objective experimentation seems reasonable. It should be possible to determine experimentally the most effective content, organization, and presentation for given kinds of messages to given kinds of audiences for particular purposes. At least, this should be true to the extent that the elements in these situations can be defined, categorized, and reproduced under experimental conditions, and to the degree that it is possible to measure the attainment of a given purpose.

The experimental approach is quite straightforward. A situation is assumed and a communication is written to meet its demands. Controlled variations are then made in the communication so that several versions of the same message are developed. A criterion test is developed to measure the degree to which the purposes of the communication are attained. Each member of a nearly-homogeneous audience is given one version of the message to read, and then all are given the same test. Appropriate statistical analyses of the test results are performed, and differences in performance on the test are assumed to be caused by differences in the effectiveness of the various forms of communication. To the degree that other situations are similar to the one assumed, communications organized and presented in the form found to be most effective in the experiment should be more successful in attaining their purposes than those organized and presented in the other forms tested.

Situation Assumed

In the three experiments completed thus far, the only variation in the assumed situation has been in the audiences. The situation was chosen because it is a common one and because it lends itself well to the mechanics of the experimental procedure.

Author

The passage is written by a man who is thoroughly familiar with the subject and who is experienced in technical writing.

Subject

The passage is a description of a simple mechanical device. Certainly this is one of the most common subjects in technical communications. It may be necessary to describe such a device to someone who is to design it, build it, modify it, sell it, transport it, demonstrate it, operate it, install it, or who may need greater or lesser degrees of understanding of the device for any of a dozen other reasons.

Purpose

The author wants to describe the physical structure and operation of the device to his readers so that they will have the understanding necessary to make the kinds of determinations or judgments about it which might be required in a work situation.

Audience

Nine audiences (over 2300 test subjects) have been tested in the three experiments. All subjects have been native speakers of English, and none has known anything about the author of the passage (the test passages are unsigned). The subjects knew nothing about the device until they read their test passages because the device has never been produced commercially and nothing but the patent has described about it. Beyond this, distinctions between audiences were made on the basis of sex, age, intelligence, technical inclination, experience with written technical communications, and instruction in technical writing. Audiences have been drawn from the student bodies at the University of Michigan, Purdue University, and the Air Force Institute of Technology, and from trainee sections at Lackland Air Force Base, Texas.

Reading Passage

The reading passage is a 3800-word description of the chosen machine (a simple "teaching machine"). It has seven main sections organized as suggested in many texts on expository writing: an introduction, five sections describing the five functional units of the machine, and a section describing the machine's operation. The passage contains ten line drawings. One illustrates the machine as a whole, one illustrates each of the five functional units, and the other four illustrate critical relationships in the structure and operation of the machine.

Criterion Test

Under the conditions assumed, the author intends to communicate his message (the structure and operation of the machine) to the reader in the most effective manner. When the content of the message has been determined, it must be organized and presented in the form most readily comprehensible to the reader and least demanding of his time. Further, the message should be so written that the readers will accept its accuracy and that the presentation will not detract from the reader's impression of the author's competence as a writer. Therefore, four measures of the effectiveness of the message were taken.

Comprehension

A 20-question multiple-choice test, with four answer choices for each question, were used. All questions required judgments, deductions, and inferences about the machine and its operation—the kind of determinations that a reader might be required to make in a working situation. The test was not intended merely to determine whether a reader could look back into the reading passage and find a particular dimension. Rather, it was intended to find out if he could determine whether that dimension would be affected if some change were made to another part of the machine—to determine whether he understood the relationships between the various parts, why they are as they are, and how they work together to contribute to the functioning of the machine as a whole.

Time

The time required by each subject to read his version of the reading passage was recorded in minutes. While this is rather a gross measure, it appears to make the desired discriminations.

Author Competence

Each subject rated the author's competence as a writer on a nine-point scale.

Author Knowledge

Each subject rated the author's knowledge of the subject matter on a nine-point scale.

The criterion test, then, measured whether the reader understood the message, how long it took him to read it, whether or not he thought it was well written, and whether or not he believed it. Gross failure of a communication in any one of these areas might wholly offset its effectiveness in the others and nullify the effectiveness of the whole. Certainly, different measures might have been taken and might well be used in other experiments with other assumed sets of conditions.

Test Variables

Because the experimental designs were factorial, it was possible to test the individual and combined effects of several variables in each experiment. Four variables were used in the first and second experiments, but only three were used in the third (where the audiences were somewhat smaller). With the exception of the first variable listed, there were two conditions on each variable—generally, it was present in half of the versions of the reading passage used in a given experiment and absent from the other half.

Presentation of Size and Shape

The size and shape of the machine and its parts were presented in three different ways.

1) Drawings alone—the drawings were dimensioned and all verbal description of size and shape was removed from the passage (used in Experiments 2 and 3).

2) Drawings plus verbal description—the drawings were not dimensioned and verbal description of sizes and shapes was contained in the accompanying text (used in all three experiments).

3) Verbal description alone—the drawings were removed from the reading passage (used in all three experiments).

Introduction (used in all three experiments)

A 236-word introduction described the function, physical appearance, conditions of use, and basic operation of the machine and indicated the order of presentation within the reading passage.

Internal Orientation (used in Experiments 2 and 3)

This material is used to keep the reader oriented and to indicate to him the pertinence of given portions of the text. The description of the physical structure of the machine and its operation would be complete without it. Sections describing physical structure included both opening and internal explanation of the functions of the parts and reasons for their being as they are. Description of the machine's operation included the introductory orientation, explanations of the reasons for the operator's actions, and sequence signals.

Headings (used in Experiments 1 and 2)

Three ranks of headings were used in the base passage. They included the seven main section headings, three subheadings, and three sub-subheadings.

Paragraphing (used in Experiment 1)

The base reading passage contained forty-five paragraphs (average length: 84.5 words). In the alternate version of this variable, each headed section or subsection was presented as a single paragraph. Thus, there were thirteen paragraphs (average length: 292 words).

Test Administration

Subjects at Purdue University and at the University of Michigan were tested in regularly scheduled classes. Those at the Air Force Institute of Technology were tested in regular classrooms but at an hour normally reserved for Commander's Call. Those at Lackland Air Force Base were tested in rooms used for classification tests and as an apparent part of their normal classification. In each audience, the versions of the reading passage were assigned to the subjects on a random basis.

Approximately five minutes of instruction was given to each test group, any questions about procedure were answered, and the subjects were told to begin. Each subject then read his reading passage, recorded his reading time, answered the test questions, and made the two judgments about the author. Three time warnings were given during the administration, and any who finished early were permitted to leave.

Statistical Measures

Because reading passages were randomly assigned to the subjects, readers of one version of the passage in a given audience might have been better readers than those assigned another version. If this were not taken into account in the statistical analysis, results would be open to serious question.

A measure of verbal ability was obtained on each subject: in five audiences it was the College Entrance Examination Board's Scholastic Aptitude Test of Verbal Abilities, in two it was the Word Knowledge Test of the Ac-2A battery of tests (U.S. Air Force), and in the other two it was Test 10 of the California Mental Maturity Test (1963 Revision/Level 5). In each audience, preliminary analysis indicated a positive relationship between verbal ability scores and scores on the comprehension test. No such relationship was found between verbal scores and the other measures taken of the effectiveness of the message. Therefore, analysis of covariance was used to analyze comprehension scores in order to normalize the effects of any differences in verbal ability between cells. Scores on the other three measures were analyzed by analysis of variance. Comparison of total comprehension between audiences was made by the Scheffé Method.

Illustration of Experimental Design

The experimental design used in Experiment 2 may be represented and shown in Table 1. It is typical of all three experiments. Four variables were used here. There were three conditions on one variable and two each on the other three, so that a total of twenty-four versions of the reading passage were necessary in a 3 × 2 × 2 × 2 factorial design. Each of the possible combinations of the conditions on the variables was present in one version of the passage. The numbers used in the table are for illustrative purposes only and had no significance in the actual experiment. The letters in each column indicate the conditions of the variables in one treatment of the message as follows:

1) Size and shape: A, drawings alone; B, drawings plus verbal description; C, verbal description alone.

Table 1

Variable	Treatment																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Size and Shape	A	A	A	A	A	A	A	A	B	B	B	B	B	B	B	B	C	C	C	C	C	C	C	C
Introduction	A	A	A	A	B	B	B	B	A	A	A	A	B	B	B	B	A	A	A	A	B	B	B	B
Internal Orientation	A	A	B	B	A	A	B	B	A	A	B	B	A	A	B	B	A	A	B	B	A	A	B	B
Headings	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B

2) Introduction, internal orientation, and headings: A, variable is present; B, variable is absent.

Thus, in Treatment 3, size and shape are presented by drawings alone, the introduction and headings are present, but the internal orienting material is absent. In Treatment 18, size and shape are presented by verbal description alone, the introduction and internal orienting material are present, and the headings are absent.

Conclusions

General

The approach appears to be workable and to make the intended discriminations.

1) The measures used distinguish differences in the effectiveness of different forms of the test communication.

2) It is possible to detect both significant differences in the effectiveness of the passage caused by individual test variables and differences caused by interactions between variables (differences not attributable to individual variables but caused by two or more acting together).

3) It is possible to distinguish between audiences—to identify variables or combinations of variables which cause a significant difference in one audience but not in another.

4) The measures used are not wholly redundant. Variables or combinations of variables which cause a significant difference by one measure of the passage's effectiveness may not cause a difference by another.

5) The results appear to be repeatable and the method is evidently a reliable predictive instrument (57 of the hypotheses tested in Experiment 1 were tested again in Experiment 2. For 56 of them [98 percent], the results were identical).

Specific

With one exception noted, all conclusions listed are significant at the 0.01 level of probability. While space does not permit listing or discussing all conclusions, those below are probably among the most interesting. They are based on the situation assumed, the materials used, and the audiences tested. The extent to which they may be applied elsewhere must await further investigation.

1) Comprehension was higher when drawings were present than when they were absent. When drawings were present, the presence or absence of the verbal description of the machine and its parts made no difference in comprehension. (This conclusion was found in five of the six audiences in which all three treatments of size and shape were used. The sixth was, by definition, the least intelligent group and the message was beyond its comprehension whatever the means by which sizes and shapes were presented).

2) The presence of drawings raised the reader's judgment of the author's competence as a writer in eight of the nine audiences tested. The ninth, again, was the audience defined as being the least intelligent.

3) When sizes and shapes were presented by drawings alone, the material was read more quickly than when they were presented by drawings plus verbal description or by verbal description alone.

4) The introduction did not increase comprehension in any of the audiences tested. (This comes as something of a shock to many teachers of English Composition!)

5) Overall comprehension increased between audiences about as might be expected. Those defined as being brighter understood the material better. Further, there is some indication that technical inclination raised comprehension above what might be expected at a given level of intelligence.

6) The structural aids (introduction, internal orienting material, headings, paragraphing) were of some benefit in some audiences, but not to the extent that might have been expected. They were overwhelmingly overpowered by the effect of the drawings.

7) There is some indication that departures from a known or expected form or pattern of organization lowers the reader's impression of the author's knowledge of the subject matter. This is based upon two main effects and two interactions in an audience which had taken a course in technical writing. While all effects were at the 0.05 level of probability, in each case the judgments were lower as the form of the reading passage departed from that which had been suggested for mechanical description in the course.

Some Implications

By this experimental method it is possible to determine whether a given element of a communication contributes to the effectiveness of that communication within a given situation. It is possible to test the relative effects of many variations of that element, whether it is an item of content, a form of organization, or a variety of presentation, and to determine whether there is a "most effective" form in which it should be presented. If a given form is found to be the most effective in one kind of communication situation, it is possible to alter any of the variables in the situation assumed and determine whether there are different effects in another. If, for example, a given range of paragraph length were found to be most effective with one group of readers, it might not be best with a definably different group. Or if a particular style or tone were found to produce the highest credibility when the author was unknown to one or another kind of reader, it might not have this effect when the author was known and regarded either with strong favor or disfavor by the reader.

The method is quite straightforward, since direct measurements are taken of the effects caused by experimental variables to determine their contributions to the effectiveness of the communication. In terms of behavioristic psychology, the stimuli are varied to determine which will produce the most desirable response.

I do not suggest that it is easy, necessary, or even possible to reproduce all varieties of communication situations under experimental conditions. And within experimental constraints it would certainly be impossible to develop criteria which would provide valid indications of the effectiveness of some kinds of passages. But with a little imagination, it ought to be possible to reproduce a wide variety of situations and to test the attainment of many kinds of purposes. The experimental approach discussed in this article is one way of going about it.

I do not imagine that we will ever be able to state with certainty the best form, content, and expression for each possible written message to each possible audience in each possible communication situation. But I do believe that we can develop objective evidence to guide us in many situations. And considering the rooms full of reports generated in the production of an automobile, the tons of paperwork developed in the building of a power plant, or the shelves full of manuals and other supporting documents necessary to maintain a single airplane, it is a little surprising to find that there just does not seem to be much controlled experimentation aimed at determining how such things should best be written to fill their functions.

In a sense, technical writing is something of an art. There are regulations and conventions within which the practitioner works, but his success depends largely upon his own feeling for the effect that will be caused by his product. Because of the increasing need for research in communications and the mounting interest in experimental means for carrying out such research, other experimental approaches are bound to be developed and tested. Some will be very different from the one discussed in this article, and some will no doubt be better. But for the present, this approach appears to make the desired discriminations and to provide a reliable predictive instrument.

Author's Note. This is a continuing project. At present I am carrying out two experiments intended to shed further light upon the effects of departures from a known or expected pattern or form. In one, the variables are departures from the standard in expression (agreement of subject and verb, run on sentences, shifts in viewpoint), and in the other they are departures in the preparation and reproduction of copy (ragged margins, sloppy typing, smudged copy). Should the results of these experiments be positive, writers, editors, and teachers will have objective evidence of the validity of much that they say on these matters. If any readers have access to suitable groups (minimum size about 120) of subjects which are available for testing (it takes about an hour) and would be interested in participating in these experiments, please contact me.

The experiments mentioned in this article are described in the following reports by the author of this paper.

REPORTS

1. "An experimental approach to effective industrial communications," Ph.D. dissertation, University of Michigan, Ann Arbor, 1962. Available from the author.
2. "Effective technical communication, mechanical description, experiment II." Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Tech. Rept. AFIT TR 65-1. Available from the Clearinghouse for Federal Scientific and Technical Information and from the Defense Documentation Center (AD-631238).
3. "Effective technical communications, mechanical description, experiment III," Air Force Institute of Technology, Tech. Rept. AFIT TR 66-15. Available gratis from the author and from the Clearinghouse for Federal Scientific and Technical Information and the Defense Documentation Center (AD-641251).

JOHN KIRKMAN

Can We Test Technical Writing Skill Objectively?

The use of subjective tests as the only method for testing technical writing ability is questioned in this article. An objective technical editing test is included. John Kirkman is in the Department of English and Liberal Studies, University of Wales, Institute of Science and Technology.

Examinations which use traditional types of questions to measure writing ability are notoriously unreliable. Essays, summaries, comprehension questions, paraphrases, even technical reports—all are assessed subjectively by an examiner, irrespective of whether he marks by general impression or according to a grid which allocates proportions of the available marks for various qualities. Ask any two or more examiners to judge the worth of a given piece of writing, and you will almost certainly get different responses.

This is true even when the subject-matter is technical and the examiners are close colleagues, whose views on what constitutes good writing seem to be very close. As evidence of this, here are the marks (Table 1) given to 94 papers from engineering students by two of my colleagues, who teach technical communication courses with me, who have considerable experience in examining both within the University and externally, and whose views on what to look for in good writing seem, in discussion, almost identical. Neither examiner knew what mark had been awarded to each script by his colleague. No writing on the paper was allowed by whoever saw the script first.

Taking 8/20 (40%) as a pass mark, 30 out of the 94 candidates were failed by one examiner but passed by the other.

For further evidence, here are the marks awarded to seven candidates by eight examiners, four engineers and four English specialists with a particular interest in scientific and technical writing. The candidates were asked simply to rewrite part of an ill-written technical report. In this way, the subject-matter to be handled by all candidates was the same (or should have been); the examiners' judgments were not affected by the need to reward originality of thought, exact memory, or judicious selection of material. The scripts from the seven candidates were typed and copied, so that all examiners had identical copies, and so that no examiner could be biased, favorably or unfavorably, by the appearance of any script (Table 2).

Table 1

Possible mark 20	
Difference in marks awarded by examiners	*Number of candidates*
0	14
1	23
2	18
3	15
4	12
5	10
6	2

Table 2. Marks Awarded to Seven Candidates by Eight Examiners (possible mark 20)

	Examiner							
Candidate	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
A	12	8	13	6	11	7	9	6
B	6	10	6	7	7	5	12	8
C	16	13	16	12	9	15	13	10
D	12	14	15	15	17	12	14	11
E	10	11	14	5	11	7	8	9
F	7	12	12	10	10	9	10	15
G	11	6	8	11	7	8	14	8

There was no grouping of examiners according to their backgrounds. There were strict and lenient engineers, and strict and lenient English specialists. The toughest marking came from an engineer! Readers will notice how a candidate's fate could have varied according to which examiner marked his script, if only one examiner had been involved and had been operating a pass mark of 8/20.

To educationists, these results are distressing, but not surprising. Research into the reliability of essay-marking regularly produces similar results.

This does not mean that traditional question types such as essays are useless as testing instruments; there are ways of using them to make a contribution to the measurement of a candidate's writing ability. But, it does mean that we cannot rely on traditional question types alone in the assessment of writing ability. We are obliged to look for other tests to combine into a battery which will give us a more reliable indication of each candidate's true worth.

In an effort to avoid difficulties created by variations in examiners' subjective judgments, I have been experimenting with a type of "objective" test of writing ability. In this test, candidates are given a rough draft of a piece of writing. They have to assume that it is something they have roughed out themselves: their task is to "edit" it—to remove solecisms and clumsy style, and to concentrate on achieving clarity, precision, and readability. They do not have to rewrite the text themselves. The parts to be revised are clearly indicated by underlining or by the use of distinctive type. For each item to be revised, five possible revisions are offered. The candidates have simply to choose which revision they think is the most suitable from the five offered.

The marking of a question presented in this way becomes entirely "objective." That is, marking is based on a previously agreed set of "best" answers, which can be produced by a large moderating panel. In this way, though there is still an element of subjectivity in the collective judgments made by the moderating panel, at least no candidate's mark depends on the whim or consistency of one or two examiners who happen to have his paper in their batch for marking.

The acceptability of this type of question depends on the acceptability of the moderating panel's judgments. But it is possible to have a large panel, so that a wide range of views can be represented. It can be agreed that no item shall be included in the final version of the test unless the "best" answer is agreed upon by more than 80 or 85 percent of the panel. The questions can be tried out carefully in pilot tests, to ensure as far as possible that no unforeseen difficulties confront the candidates, and that unduly hard or unduly easy items in the question are eliminated. All this means that preliminary versions of an "editing" question must include many more items than will be needed, so that those which do not produce 80 or 85 percent agreement from the panel, or those which prove too hard or too easy in pilot tests can be discarded.

Can we ever get 85 percent agreement from a moderating panel, especially a panel of engineers or technical writers, about the best answers to an editing question? I should like to invite readers to join me in finding out. The remainder of this article consists of an editing test, aimed at assessing the competence of potential technical writers. From the 24 draft items following the text, it would be desirable to produce 15 or 20 acceptable items, giving a test which would occupy 45 minutes or an hour in its final form. Readers are invited to make a copy of, and complete, the answer sheet, and send it to me at the following address:

John Kirkman
Department of English and Liberal Studies
UWIST
King Edward 7th Avenue
Cardiff, Wales
(Please use airmail!)

If you would like to receive details of the overall response from the "panel" of readers who reply, please give your name and address in the space on the answer sheet.

Editing Test I

The passage below is part of the first draft of an article about numerical controls, intended for a technical journal for engineering readers. Some parts of the draft have been italicized because they are ungrammatical, wordy, woolly, or indigestible. Your task is mainly to suggest ways in which they could be made more direct, clear, and "readable."

Read the passage carefully, ignoring the italicizing for the time being, and concentrating on getting the gist of the narrative. Then answer the questions that follow the passage.

MACHINA 300 and 301, TWO NUMERICAL CONTROLS FOR DRILLS, BORING MACHINES, MILLING MACHINES, MACHINING CENTERS, AND JIG BORING MACHINES

Numerically controlled machine tools offer both economic and technological advantages. Indeed, certain difficult machining operations would be impossible without them. The advantages of numerical controls are demonstrated particularly clearly on machining centers that have become available recently.

The MACHINA 299, which has been on the market for two years, is a standard numerical straight-cut control for drills, boring machines, and milling machines. *The achievement of automatic wiring and testing has been made possible by means of the device of standardization with other earlier controls. Simplification of commissioning has also been an added advantage accruing from this standardization.* The MACHINA 300 and 301 are further developments of the 299.

A numerical control system should be versatile. To achieve this versatility, its construction must be flexible. This flexibility will permit the control of a large number of movements of the machine tool. Also, the control will become capable of handling a large number of switching operations on the tool. To give maximum economic efficiency, a control should . . . *(have included in its construction)* . . . features to shorten clamping time, setting-up, and general machine downtime. The MACHINA 300 and 301 include the following features:

a. Zero point selection on and away from the workpiece.
b. There is a zero shift changeover for reciprocal machining.
c. An adequate number of tool compensations.
d. The program may be interrupted at any time.
e. Testing of new punched tapes for correct work and block format.
f. Single blocks can be operated to facilitate testing of difficult machining operations.

The MACHINA 300 and 301 are designed for the following two codes, which are the most important two in use at present, it being necessary to have a standard programming system for the design of standard controls:

a. EIA code (Electronic Industries Association), which also corresponds to the NAS code (National Aerospace Standard).
b. ISO code (International Organization for Standardization), which has been adopted in British Standard 00000.

With these basic features in their construction, two types of optional extras are available in the MACHINA 300 and 301. Basic and optional features combine to give optimum flexibility. *The two types of optional extra features are simple functions for which provision is made in the wiring of the basic design and which are added by plugging in additional printed circuit boards and complex functions which have their own group frame and are connected via cables and plugs.* The large number of *items or functions which may be increased or decreased at will* thereby made available in the MACHINA 300 and 301 permit the machining of complex workpieces in one clamping operation.

The *machina* 300 is designed for operation in a maximum of four axes and the MACHINA 301 in a maximum of five axes. A round table, for instance, can be programmed to any position within 360° with a programmed resolution of 0.001°. The tool of a facing head can be set with a programmed resolution of 0.001 mm. *It can readily be seen that these facilities give a potential for boring to fit tolerances.*

For withdrawal of the facing head in the *z* direction without damaging the finished bore, the spindle must be stopped at a certain *angle, preferably the spindle should be braked* by a programmed . . . *(filling an additional supporting role)* . . . function so that the tool comes to rest pointing vertically *upwards. Further reading-in of the punched tape being prevented until the spindle has stopped.* The *y* axis is then lowered by a few tenths of a millimeter and the *z* axis *whipped out* easily.

Punched Tape Capacity and Reading Time

It is possible to accommodate programs of up to 8 hours' duration on 100 m of punched tape. The punched-tape reader *works in a step by step start-stop rapid flow tape scanning operation* at 120 characters per second. At this speed the total reading time of the 100 m of tape is 5.6 minutes. Rewinding time need not be included, since the tape rewinds while the workpiece is being changed; *there is no rewinding in the case of looped tapes.* A factor that affects the total time much more than the reading time is the approach time per position. Depending on the design of the drive and the rigidity of the machine, the approach time *has a value of the order of the range 0.5-5 seconds* and takes up 3 to 30% of the 8 hours mentioned previously.

High-Speed Feed Drives

In the Machina 301, provision is made for the control of fast variable-speed feed drives, the drive itself possibly being a d.c. motor or a hydraulic drive, and the possible feed rate which can be programmed being from 10 to 10,000 mm/min in geometrical steps of 1.125. An additional rapid traverse step is possible via a clutch. From a preset limit onwards the rapid traverse speed of 10 m/min *is reduced* continuously to standstill during the approach to the required position. The approach characteristic is selected to give a minimum approach time without overshooting.

Editing Test II

In the questions below, various ways of improving parts of the passage are suggested. In each question, choose the revision which would help to create the most direct, clear, and readable text. Choose only *one* answer for each question. If you have no idea of the answer, do not guess; move on to the next question. Record your answers carefully on the answer sheet.

1. *The achievement of . . . this standardization* (lines 8–11)
   a. Automatic wiring and testing has been made possible by the device of standardization with earlier controls, simplification of commissioning, too.
   b. As a result of standardization with earlier controls, the possibility of automatic wiring and testing has been introduced and simplification of commissioning has been achieved.
   c. Simplified commissioning, automatic wiring, and automatic testing are all possibilities accruing from the device of standardization with earlier controls.
   d. Standardization with earlier controls has made automatic wiring and testing possible. It has also simplified commissioning.
   e. Simplification of commissioning and wiring and testing automation have been achieved through standardization with previously produced controls.
2. *A numerical control system . . . operations on the tool (lines 13*–17)
   a. Numerical control system versatility demands construction flexibility thereby permitting control of extensive machine tool movement and multiple switching operation.
   b. A highly desirable feature to be built into any numerical control system is versatility which means that to permit the control of a large number of movements and switching operations on the machine tool its construction must be flexible.
   c. Versatility is a very desirable feature in any numerical control system and this requires that the construction of the system must be of a flexible nature. By virtue of this flexibility, it will then be possible to exercise control over a considerable number of movements and a similarly substantial number of switching operations on the machine tool in question.
   d. A numerical control system must be of flexible construction to make it versatile. The desirability of this is because it will permit control of a large number of movements and switching operations on the machine tool.
   e. A numerical control system should be versatile. Accordingly, it must be built in a way which will permit the control of a large number of movements and switching operations on the machine tool.

3. The best word to give the meaning *have included in its construction* in line 19 would be:
   a. incorporate
   b. inculcate
   c. implicate
   d. infiltrate
   e. instigate

4. Grammatically, and for comfort of reading, the six features listed in lines 22–29 would be better set out if the statements a to f:
   a. were arranged in alphabetical order;
   b. all ended with colons;
   c. were set out in a continuous paragraph, not as a list;
   d. were arranged in order of increasing length;
   e. all had the same sentence structure.

5. *The MACHINA 300 and . . . of standard controls:* (lines 30–33)
   a. Since standard control design necessitates utilization of a standard programming system, hence the MACHINA 300 and 301 are designed for the following two currently most important codes:
   b. The MACHINA 300 and 301, since it is necessary to have a standardized programming system for the design of controls which are standardized, are designed for the following two codes, which, at present, are the most important two in use:
   c. For the design of standard controls it is necessary to have a standard programming system. The MACHINA 300 and 301 are designed for the following codes, which are the most important in use at present:
   d. It is found that for the design of standard controls it is essential that a standard programming system be utilized. It is for this reason that the MACHINA 300 and 301 are designed in such a way that the following two codes—the most important two currently being utilized—can be used:
   e. It being necessary to have a standard programming system for the design of standard controls, the MACHINA 300 and 301 are designed for the following two codes, these being the most important two in use at the present moment:

6. *With these basic . . . the MACHINA 300 and 301* (lines 38–39)

- a. These basic features being in their construction, two types of optional extra are available in the MACHINA 300 and 301.
- b. Over and above these basic features in their construction, two types of optional features are provided in the MACHINA 300 and 301.
- c. These basic features having been included in their construction, two types of optional extras feature in the MACHINA 300 and 301.
- d. In addition to these basic features in their construction, the MACHINA 300 and 301 can have two types of optional extras.
- e. Two types of optional extras, in addition to having these basic features in their construction, are available for the MACHINA 300 and 301.

7. *The two types of . . . via cables and plugs* (lines 40–45)
   - a. The two types of optional feature are:
     - i. simple functions, for which provision is made in the wiring of the basic design and which are added by plugging in printed circuit boards;
     - ii. complex functions, which have their own group frame and are connected via cables and plugs.
   - b. The two types of optional features are as follows. Firstly, simple functions for which provision is made on the basic design wiring and the addition of which is achieved by the plugging in of additional printed circuit boards. Second, complex functions, having their own group frame and connected via cables and plugs.
   - c. Simple functions (additive by plug-in of printed circuit boards accommodated in basic design wiring) and complex functions (group-framed separately with cable and plug connections) constitute the two optional feature types.
   - d. These are the two types of optional features:
     - i. Simple functions (Provision made in wiring of basic design. Addition by plugging in additional printed circuit boards.)
     - ii. Complex functions which have their own group frame and are connected via cables and plugs.
   - e. The two types of optional features are: Simple functions, for which the wiring of the basic design makes provision. These are added to the control by plugging in additional printed

circuit boards. On the other hand, there are Complex functions, which have their own group frame and are connected via cables and plugs.

8. The best word to give the meaning *items or functions which may be increased or decreased at will* in lines 45–46 would be:
   a. transients
   b. variables
   c. parameters
   d. features
   e. movables

9. The word *machina* in line 49 should have been in capitals. Which is the standard text mark to indicate to the printer that the type size should be changed to capitals?
   a. $\underline{\text{machina}}$
   b. $\underline{\underline{\text{machina}}}$
   c. $\uwave{\text{machina}}$
   d. $\underline{\underline{\underline{\text{machina}}}}$
   e. $\boxed{\text{machina}}$

10. *It can readily be seen that . . . fit tolerances* (lines 54–55)
   a. As a result, boring to fit tolerances is possible.
   b. Hence a potential for boring to fit tolerances is derived.
   c. Boring to fit tolerances thus becomes a viable proposition.
   d. Hence the possibility of boring to fit tolerances arises.
   e. It is therefore possible to carry out the process of boring to fit tolerances.

11. *angle, preferably the spindle should be braked* (line 58)
   a. angle. Preferably, the spindle should be braked
   b. angle, the spindle preferably being braked
   c. angle; preferably, the spindle being braked
   d. angle, preferably the spindle being braked
   e. angle—preferably the spindle should be braked

12. The best word to give the meaning *filling an additional supporting role* in line 59 would be:
   a. moderating
   b. reserve

c. subordinate
d. auxiliary
e. peripheral

13. *upwards. Further reading-in . . . the spindle has stopped* (lines 61–62)
    a. upwards. (Further reading-in of the punched tape being prevented until the spindle has stopped.)
    b. upwards; further reading-in of the punched tape being prevented until the spindle has stopped.
    c. upwards. Further reading-in of the punched tape is prevented until the spindle has stopped.
    d. upwards; further reading-in of the punched tape is prevented until the spindle has stopped.
    e. upwards, and further reading-in of the punched tape is prevented until the spindle has stopped.
14. The word "withdrawn" would be preferable to the words *whipped out* in line 63. The objection to *whipped out* is:
    a. The phrasing is grammatically inaccurate.
    b. The words slip below the appropriate level of formality.
    c. The meaning of the phrase is obscure in this context.
    d. The use of metaphorical language is not acceptable in technical writing.
    e. The phrase is not so easily readable or digestible as "withdrawn."
15. *works in step by step . . . scanning operation* (lines 67–68)
    a. works in a start-stop manner, scanning over the tape step by step yet rapidly
    b. scans the tape rapidly, step by step in a start-stop motion
    c. works in a step by step, start-stop, rapid flow, tape-scanning, operation
    d. tape-scans in a stepwise, high flow-rate, start-stop motion
    e. operates by moving the tape along rapidly and scanning it step by step in a continuous series of start-stop movements
16. *there is no rewinding . . . looped tapes* (lines 71–72)
    a. as far as looped tapes are concerned, there is no rewinding.
    b. where looped tapes are utilized, no rewinding occurs.

c. looped tapes obviate the rewinding function.
d. for tapes in the form of loops no tape rewind is required.
e. there is no rewinding of looped tapes.

17. *has a value . . . seconds* (line 75)
    a. falls approximately within the range of 0.5 and 5 seconds
    b. is between 0.5 and 5 seconds
    c. has values ranging from 0.5 to 5 seconds
    d. is of the order of 0.5 to 5 seconds
    e. varies within the range 0.5 to 5 seconds

18. *In the MACHINA . . . steps of 1.125* (lines 78–82)
    a. A feature of the MACHINA 301 is that control of fast variable-speed feed drives are provided for, possibly drive through a d.c. motor or a hydraulic drive. The possible feed rate can be programmed from 10 to 10,000 mm/min in geometrical steps of 1.125.
    b. The MACHINA 301 provides for control of fast variable-speed feed drives. The feed drive itself may consist of a d.c. motor or a hydraulic drive. The feed rate can be programmed from 10 to 10,000 mm/min in geometrical steps of 1.125.
    c. Control of fast variable-speed feed drives is provided for in the MACHINA 301. The drive may be a d.c. motor or might be a hydraulic drive. The feed rate can be programmed in geometrical steps of 1.125 through a range of 10 up to 10,000 mm/min.
    d. Fast, variable-speed feed drive control at programmable feed rates from 10 to 10,000 mm/min in geometrical steps of 1.125 governing drives which may be d.c. motors or hydraulic drives is provided for in the MACHINA 301.
    e. Provision is made for the control of fast variable-speed feed drives in the MACHINA 301 which may be a d.c. motor or a hydraulic drive. Possible programmable feed rates are from 10 to 10,000 mm/min in geometrical steps of 1.125.

19. All but *one* of the following words could be substituted for *is reduced* in line 84 without changing the meaning of the text. Which word would *not* be acceptable?
    a. drops
    b. declines

c. decreases
d. diminishes
e. deteriorates

20. The following piece of information has inadvertently been omitted from the passage:

"Some machining jobs call for rotation of the workpiece about the *y* axis by a rotary table, together with swiveling about the *x* axis. This swiveling movement can be controlled numerically as a fifth axis or through limit switches as a pseudo-coordinate."

The best place to insert this information would be:

a. After "plugs" in line 45
b. After "operation" in line 48
c. After "easily" in line 63
d. After "previously" in line 76
e. After "overshooting" in line 87

21. The best subheading to go between lines 12 and 13 would be:

a. How the 300 and 301 are Built
b. A Desirable Mixture of Construction Features
c. Further Developments of the 299
d. Basic and Optional Construction Features
e. Design for Maximum Economic Efficiency

22. The subheading *Multi-Axis Control* would best be placed:

a. Between lines 29–30
b. Between lines 37–38
c. After "plugs" in line 45
d. Between lines 48–49
e. Between lines 55–56

23. The remainder of the article consists of sections with the following subheadings:

A) Fixed Position Cycles Shorten Program Tapes
B) The Accuracy of Numerical Controls
C) Hand Input of Information in Emergencies
D) Rapid Simultaneous Positioning of Axes
E) Programming for Tool Compensation in Positioning

Which would be the best arrangement of these remaining sections following the existing text?

a. B C A D E

b. D E A C B

c. C B A D E

d. E A C D B

e. D B E A C

24. Assume that you have to produce a technical sales leaflet, based on the data in the text above and aimed at chief engineers in companies which might use the MACHINA 300 and 301. Which of the following statements would be the best opening sentence for your copy?

a. Over the years, numerical controls have been developed which can be used extensively with drills, boring machines, milling machines, machining centers, and jig boring machines.

b. Our new numerical controls, the MACHINA 300 and 301, permit large numbers of movements and switching operations, and shorten clamping time, setting-up time, and general machine downtime.

c. A common problem on machining is that clamping and setting-up "waste" much time that could otherwise be utilized more economically in actual machining.

d. Here they are at last—two numerical controls to answer all your prayers for multiple movements, flexible switching operations, cuts in clamping and setting-up time, and vast savings in general machine downtime.

e. The well known Machine Ltd. numerical control, MACHINA 299, has demonstrated its reliability for more than two years now.

Answer Sheet

Question number	Question number	Question number	Question number
1 ______	7 ______	13 ______	19 ______
2 ______	8 ______	14 ______	20 ______
3 ______	9 ______	15 ______	21 ______
4 ______	10 ______	16 ______	22 ______
5 ______	11 ______	17 ______	23 ______
6 ______	12 ______	18 ______	24 ______

Name and address to which a statement of the "panel" of readers' responses should be sent: ____________________

____

____

____

____

Would this type of question be acceptable as *part* of a qualifying examination for would-be technical writers? ____________

____

How much time should be allowed for answering

a. this test? ____________

b. a version with only 20 questions? ____________

c. a version with only 15 questions? ____________

Any suggestions for additional questions? Or any other comments?

THOMAS M. SAWYER

Examining Scientific and Technical Literature

Professors emeriti from scientific and technological fields, as well as from the humanities, can usefully serve, the author believes, as external examiners to determine a student's final grade in a scientific and technical communications course. Thomas M. Sawyer is in the Department of Humanities, College of Engineering, University of Michigan.

In the Winter 1973 issue of *The Journal of Technical Writing and Communication* Dr. John Kirkman asks: "Can we test technical writing objectively?" Dr. Kirkman complains that examiners of technical writing vary widely in their assessments of the student's ability, and the student's chances of passing or failing depend upon which examiner he has the luck to draw. For this reason, Dr. Kirkman proposed that an objective test, one upon which a large panel has agreed on the "best" of several alternative answers to a battery of questions, might be used to supplement the subjective judgments of the examiner.

In May 1972 I had the good fortune to sit in on a course in technical writing and speaking that Dr. Kirkman and his colleague, Mr. Alban Levy, gave at the beautiful Dyffren House not far from Cardiff, as well as to sit in on a similar course that they gave at Loughborough University. Both men are fine teachers. Both courses were tightly and efficiently organized; both sets of students were worked hard, enjoyed the course, and profited from it. So I am sure that Dr. Kirkman knows what he is talking about.

But after visiting Dr. Kirkman's institution, the University of Wales Institute of Science and Technology, and other British universities, I decided to take a tack almost opposite to Dr. Kirkman's. One thing I vowed to do when I returned to the United States was to experiment with the External Examiner system used in British universities.

This system probably needs some explanation.

Most British university degree programs are specialized and limited to one subject. A student studying mathematics or mechanical engineering will take nearly all his courses in mathematics or mechanical engineering. Very few other courses, and only those which bear upon his degree specialty, will be included in his program. In this respect a British first degree program resembles an American graduate degree program much more than it does an American undergraduate degree program which has distribution requirements and requires elective courses in fields other than the specialty.

Moreover, the degree that the British student receives at the end of his program—that is, a First, Second, Third, or Fourth Class Degree—is determined by an External Examiner from another institution. It is the Board of Studies of the degree program, comparable to a degree program committee in the U.S., empowered to decide upon the courses to be included in the program, their arrangement, and their content, which nominates this External Examiner. His function is to serve as a quality check on the students about to graduate from the program. Naturally the External Examiner should be a man who is familiar with the special field and knowledgeable about the programs and students at other institutions. As I understand it, the method by which he assesses the students may take a variety of forms, but the form of examination is usually settled in a discussion with the Board of Studies.

Why was I so taken with this system?

For one thing, as a former harassed and worried department chairman I found that it was fairly easy to assess a colleague's research: his publications were there to inspect, and to measure his service. An effective and persuasive committee member was easy to spot; but, it was devilishly difficult to measure the effectiveness of his teaching. Teachers of English rarely put their students on public display. Most of the writing done in English classes is not designed for publication: it is designed to satisfy the English teacher that the student can write grammatically and in an organized fashion, and/or that the student has really understood a work of literature he was assigned to read. Only rarely will someone else read one of these papers.

Thus, there is a sort of private, therapist-patient relationship between the average English teacher and his student. Any attempt to invade this privacy, to visit the classroom where this therapy is taking place, is disturbing. And any requests to inspect the results of this therapy are equally disturbing. You will even run into resistance if you ask for reports from the student-patients about the effectiveness of the teacher-therapist. And if you do manage to get student evaluations, you are likely to learn more about the rapport between student and teacher than you are about the skills the student has learned.

Now I teach some of the departmental speech courses, and it seems silly to claim that one is teaching public speaking when the student never speaks in public. So each term, with sweaty palms and my heart in my mouth, I watch some of my engineering students take on the Literary College Varsity Debate Squad, usually in front of a standing room only audience—last term with the Dean of my college among the crowd. If I have done a poor job of teaching, a lot of people are going to know it.

But I also teach the departmental course in Scientific and Technical Communication for senior students about to graduate. The objective of this course is to train these students in how to present their own specialties, both orally and on paper, in such a way that a professional engineer will approve of it and an educated layman can understand it. Was there not some way in which these students could be exposed to a public test as my speech students are?

As I learned more about Dr. Kirkman's institution and other British universities, the more interested I became in the External Examiner system as an answer. For years I had been complaining about the lack of good evidence of teaching ability. It was time to put my money where my mouth was, to give the present chairman, Professor Richard Young, some way of judging if he was getting his money's worth out of me as a teacher in that course. An External Examiner might be helpful to him.

Alas, there was one difficulty, as Dr. Kirkman pointed out to me. The External Examiner has to *work* at his job. In Great Britain he gets *paid* for it. Did I have the funds available for this idea? The answer, of course, was no.

But then I had an idea. There are a number of emeriti professors around our campus. I was pretty sure that a number of them wish they were still in the classroom; many of them are just as active and vigorous as they were when they were full-time teachers. Moreover, they probably have a better idea of the quality of different programs across the nation than do some of their younger replacements. I should probably need two people—one engineer, one layman or nonengineer—since the objective of the course was to satisfy both. And I should want some topnotch men. Would some of these emeriti professors be willing to evaluate my students just for the fun of it?

The answer was, "yes." The very first ones I asked accepted my invitation. Associate Dean Emeritus Walter Emmons, a civil engineer, and Professor Axel Marin, a mechanical engineer, took turns evaluating the students. Out of curiosity, present Associate Dean Hansford Farris, an electrical engineer, attended also, and from the Literary College English Department Professor Emeritus Arno Bader, who for many years administered the Hopwood Creative Writing Contest, came to listen.

I say *listen* because these men came to four separate class meetings to hear three or four ten-minute oral presentations each day and to ask questions of each speaker. To ask the examiners to read and mark the written version of the same report as well seemed to me, at least this first time around, to be asking rather much of people who were donating their services. However, when I repeat this procedure in coming terms, I plan to give each examiner in advance of the oral presentation copies of each student's report to comment on as he sees fit.

The students' reports dealt with everything from the design of a river towboat, to gamma-ray spectroscopy, to programming a PDP-8 computer. Each examiner ranked or graded the students and wrote brief comments about them. Happily, from my point of view, they were favorably impressed and were generous in their grading. Professor Bader was kind enough to note in his written comments that he had enjoyed himself and found this to be a conference of scholars, not an exam.

I discovered one unexpected side effect in this procedure. Once the students were told that these External Examiners were going to determine their grades, my relationship to the class subtly changed from one of judge, with sometimes arbitrary standards, to one of coach whose function it was to help them win the big game—a nice feeling.

I also rediscovered a less pleasant feeling. For four solid days my palms were sweaty and my heart was in my mouth as each student rose to face his examiners. But, it was worth it! Now I plan to repeat this procedure each term.

7

The Nexus: School and Industry

DAVID M. MCLEAN

The Demands of Industry on the Technical Writer

The work of a typical technical writer in a company representative of the aerospace industry today is described by the author, who then discusses the criteria used by this company to select a technical writer. Previously unpublished, the paper appears in this volume as it was presented at the ninth annual Southeastern Regional Conference on English in the Two-Year College, Jackson, Mississippi, February 21, 1974. David M. McLean is in the Presentations Department at Martin Marietta Aerospace, Orlando, Florida.

Before we can discuss what industry demands of the technical writer, we need to take a brief look at industry, particularly the aerospace industry, and the framework in which the writer/editor operates. The Orlando Division of the Martin Marietta Corporation is a typical example of an aerospace company; that is, a company in the business to design, develop, test, and manufacture systems for the Department of Defense.

At the Orlando Division, we have approximately 7,000 employees housed in a modern facility on 2,600 acres southwest of Orlando, Florida. Our products include surface-to-surface systems, ballistic defense systems, strategic air defense systems, tactical air defense systems, tactical weapon systems, and communications systems in support of the military services.

As part of the 7,000 employees, we have a group we call the Presentations Department. This group consists of about 250 personnel of which 50 are writer/editors. The writer/editors, assigned to the specific product areas, are responsible for all forms of communications—we will get to these in a moment. The non-editorial groups are the support areas, such as the print shop, photo lab, and so forth. As you will see, we have a total inhouse capability.

For copy preparation and layout, we have a complement of IBM magnetic tape Selectric typewriters and composers staffed by competent personnel working two shifts per day. This gives us the capability to rapidly produce justified as well as unjustified copy in a variety of type faces.

Art requirements are produced by skilled illustrators proficient in design and report art. They prepare, working two shifts per day, complex line art, slide art, and conceptual art.

Our still photographic laboratory, staffed two shifts per day, is equipped with automatic black and white and color processing facilities as well as copy cameras, enlarging equipment, step-and-repeat equipment, and a large studio. Over 50,000 color prints and 70,000 black and white prints are processed annually. Negative and positive work is also accomplished in support of printed circuit manufacturing—with line width tolerances of five ten-thousands of an inch.

Our print shop supports everything from simple reproduction and copy work to four-color process printing. Supporting us three shifts per day, the print shop turns out over four-million units per month.

In the audiovisuals area, we have a complete motion picture operation, including a sound studio. Our closed circuit color television operation provides the capability for producing training tapes for both inhouse and customer use. Vugraph transparencies, one of our most popular items, can be prepared very rapidly by our visual aids personnel using the latest equipment.

Our Technical Information Center contains over 15,000 scientific, technical, general reference, and management-oriented volumes. Over 110,000 reports are filed in hard copy.

The reproduction area maintains accountability and control of all released, or official, engineering drawings. In addition to the standard drawing reproduction equipment, this area microfilms all drawings and maintains a central computer operation that permits engineers to call up drawings on monitors throughout the plant.

With all these wonderful support facilities, and a staff of 50 writer/editors, who are our audiences and what types of communications do we handle?

Our audience is a large one consisting of many diverse groups.

Since our customer is the Department of Defense, our biggest audience is the Department of Defense and the military services. But the Department of Defense is divided into many directorates and agencies; so are the services, and each has its own goals and objectives. And then there is Congress—Congressmen vote on whether or not our programs are needed, and if they are, how many dollars should be spent on them. The general public is an audience; even though we do not produce consumer goods, the general public owns our stock. In addition, we are part of the community, and we want good community relations. Our employees are another audience. And since we recruit new college hires each year, college students are another audience. Each year we produce material specifically aimed at each of these audiences.

The types of communications material we produce cover the entire spectrum. But our bread and butter are the technical report and the technical proposal. Most of our contracts include specific reporting requirements, and our customers pay us to produce the reports. Technical proposals, on the other hand, are necessary to win new contracts. In addition to the reports, many contracts call for design reviews, briefings, and progress films. In support of these contract requirements, and in support of our marketing personnel, we produce many visual aids and films.

Many other items are required to support our marketing objectives: fact sheets, flyers, brochures, giveaways, hardware photos, trade journal covers and articles, trade show displays, and the like. This is where the writer/editor comes in. He produces all this material. It is in this context, then, that we will discuss the role of the writer/editor and what we expect from him.

In the case of each of these many forms of communications, the writer/editor produces the material, and more often than not, the material is the primary interface between the corporation and the customer or prospective customer. On a typical contract, it takes months to produce hardware and often years to produce a total system. In the interim, much of the corporation's reputation and its performance on the contract are measured in terms of the reports it submits.

The writer/editor, therefore, has two primary objectives. In terms of the report or proposal, the objective is to publish a logical, meaningful document that fulfills its objectives. In terms of marketing materials, the objective is to define a communications problem and develop an effective solution. Since the reports and proposals are our bread and butter, I will orient my remarks toward their specific objectives.

Given an assignment, the writer/editor must first determine the objectives for that assignment. If a report, is it a test report, a progress report, a final report—the objective for each type of report is different, and the writer/editor must know that objective. Several years ago a report was submitted to us for publication by an engineer. It was a test report on a hardware item, and, consequently, the objective of the report was to present the results of the test. The report input stated that the test fixture had failed during the test, and that a redesigned test fixture was being readied for a retest. The writer/editor concluded from his preliminary review that the test had not been conducted, and therefore a report on results of the test could not be written. He was right, and the report, which was no more than an account of a test fixture, was not published.

The writer/editor has to analyze his audience. Even within the same military agency, the audience varies. Specifically, for example, an aerodynamic wind tunnel test of a missile system has to be reported on in a test report and in a monthly technical progress report. The audience for the test report is a competent aerodynamist who wants to analyze the detailed data for the military. On the other hand, the military program manager is the audience for the monthly technical progress report. Although he is technically competent, he may not be an aerodynamist. In any case, he does not want the specific details—he wants to know the overall results and how the results impact the overall program. Since our aerodynamist who conducted the test will prepare both inputs in considerable technical detail, the writer/editor must know the specific audience and rewrite accordingly.

The writer/editor must also determine the specific contractual requirements for each assignment. Many contracts dictate specific contents, format, or even page limitations. The writer/editor must know these requirements before he can successfully fulfill the contractual requirements.

Having determined the objective, analyzed the audience, and reviewed the contract requirements, the writer/editor must scan the input for overall organization, redundancy, contradictions, inconsistencies, incompleteness, and logic of conclusions and recommendations. While he must depend on the competence of the engineer who wrote the report for the basic material and the specific data points, the writer/editor has the responsibility to determine if the report communicates. The design and test work done by engineers is certainly based on logic, and their thinking is generally very logical; but many of them produce illogical copy. Perhaps they are too close to their work, or they prefer to do design work rather than write about it, or they had too little time to properly prepare the report. Whatever the reason, the engineers are educated as engineers rather than as communicators—so the writer/editor, as an expert communicator, must ensure that the report communicates.

Once the writer/editor has determined the overall problems with the input, he must accomplish the reorganization, resolve the inconsistencies, rewrite as necessary, and solicit additional inputs as required. In doing this, he must be a master politician. Although engineers may be poor writers, they are human beings and their copy represents a personal output on their part. You will turn an engineer against you if you tell him his copy stinks. On the other hand, by being tactful, he will soon learn to depend on you because you make his reports, and consequently him, look better. A young writer/editor was very upset one time when a grizzled old engineer complimented him on a report, saying, "That was a great job, you didn't change a thing." Since the young writer/editor had completely reorganized and rewritten the report, he felt like the engineer didn't appreciate his efforts. It took me quite a while to convince him that he had done a superior job in that he accomplished a difficult task without changing the technical meaning or irritating the engineer.

With the overall content edit complete, the detail edit begins. Grammar, spelling, and punctuation must be corrected, facts must be checked out, tabular material must be formatted in an understandable manner, art work must be edited, and numerous other detail-edit functions performed. Although these functions are important and must be done, I am only briefly mentioning them because the treatment of overall content is much more important in terms of total contribution.

After the content review and detail edit, the writer/editor is sufficiently knowledgeable about the material to write a succinct, meaningful summary. The summary presents, for management-level personnel, the most important items in the report and their significance in terms of the overall program. The material is then processed through the production operations and submitted to the customer.

With this brief overview of the writer/editor's role, you can better understand the skills required to perform this role.

The most important single skill required of a writer/editor is to have his head screwed on right. That is, he must have common sense; he must be able to handle himself well on his feet. In our real-world environment, he will be working with all levels of personnel, from vice presidents right on down, and he must be able to display common sense as well as job-related knowledge in order to gain the respect and confidence of those he is dealing with.

The writer/editor must be able to work under pressure. Tight schedules and deadlines are as much a part of our daily routine as they are a part of the news media. Requests for proposals often come in with only 30 days permitted for a response. Several days are used up by the postal service in delivering the request, and the remaining days must be divided among conducting a market analysis to see if we should bid, accomplishing the preliminary design work, writing, editing, and publishing the proposal, and delivering it to the requesting agency. All this means tight deadlines, and often overtime. In addition to tight deadlines, each writer/editor generally has several assignments going at the same time. So pressure is very much a part of our industry.

The ability to see the big picture—the overall significance—is an important characteristic of the successful writer/editor. The best detail edit possible is poor at best if the significant message does not come through loud and clear. Our technical directors often say that the writer/editors have a better overall understanding of the programs than the engineers. This is because the writer/editor works with all the various engineering disciplines, and in addition, is keenly aware of the marketing objectives and strategy, while the engineers often have tunnel vision, limited to their own particular discipline. Without this capability for total overview, the writer/editor could only give a tunnel-vision edit.

The writer/editor must be able to compromise—and more importantly, know when to compromise and when to hold his ground. A writer/editor who is persistent in every little detail will win the battles, but he will lose the war. In working with other people's inputs, the rewrite and editorial function is a give-and-take situation. For example, a writer/editor who fights the author on every word will find himself also fighting with the author on the basic organization. On the other hand, if he compromises with the author on the minor items, he will find the author more susceptible to the significant changes.

A writer/editor must be able to work alone on some assignments and as a team member on other assignments. And the role is different in each case. On an assignment where the writer/editor works alone, he is responsible for the entire effort and must therefore do everything that is necessary to meet all objectives. On the other hand, if he is working as a team member, he will only have responsibility for a segment. One proposal we submitted back in the sixties took a year to prepare, and the final submittal was over 23,000 pages long. Over the year, more than 25 writer/editors were assigned to the effort. Each writer/editor, obviously, could not be responsible for overall organization, content, message, and so forth, so each was given a piece of the action. The supervisor and group leaders had to be responsible for the overall content and organization, so the individual writer/editors were relieved of that responsibility. But they had to be very careful about style, abbreviations, and format since their copy had to be consistent with that of other writer/editors.

The writer/editor must be proficient in human relations to deal with the authors and editorial support groups. The writer/editor must positively influence authors so that they realize the maximum effectiveness of their technical expression and mature professionally in the process. If an author is allowed to sluff off and submit poor inputs, each subsequent input will generally get worse. But if the author is required to exercise his logic in terms of writing, he will usually meet the challenge by providing better copy. The ability to properly interface with the editorial support groups is necessary to derive maximum benefit from their services. This places the writer/editor in the roll of pseudo manager and specialist. To a very great degree, he controls and influences the particular functions when his job is going through the system. He is very much like the home builder who subcontracts his own home, and is anxious that each of the subcontractors gives him the most for his money.

Based on these skills required of a writer/editor, let's take a look at some of the specific evaluation factors we use in our college recruiting.

We certainly want to see demonstrated writing skills. The writing samples of applicants carry a lot of weight in our evaluation since they are a good indication of ability. The samples that are well organized and meaningful tell us something, particularly if the applicant understands what he has written about. Samples that have careless mistakes—typos and misspellings—certainly don't help an applicant. Students are often stunned when we review their work and point out errors, or ask questions about their material that they cannot answer. But since we interview a hundred applicants or so each year, and hire only five or six, our standards are high.

We look for more than just class-assignment material. Specifically, we look for applicants who have taken part-time jobs in the communications field. While those working in construction or as waiters may earn more from their part-time jobs, those working in the communications field have demonstrated a professional commitment and have gained valuable experience as well.

Research capability is another key factor in evaluation since the writer/editor has to do so much research. In addition to the actual research, we question applicants to see if they understand the material they have researched or if they just copied down material without understanding it. Shallow knowledge and lack of understanding about a subject in writing samples represent a superficial treatment and are negative factors in our evaluation.

An interest in science and math is almost a must for our writer/editors. Although the writer/editors we have now have degrees in a wide range of subjects—including law, romance languages, psychology, business, geology, music, and sociology, as well as journalism, communications, and technical subjects—they have an interest in and an aptitude for science and technology. An applicant who tells us he wants to be a technical writer/editor but took all his electives in sociology doesn't convince us. Electives in science, math, and engineering courses demonstrate a true interest in technology.

Although not nearly as significant as the items mentioned already, a knowledge of production processes is an asset to us, and students with printing or photo lab experience get a higher rating. This type of knowledge is generally only attained by actual work experience, so it often directly relates to on-the-job writing experience.

Appearance is also important. Since our writer/editors are in daily contact with people in high management positions, they must be presentable enough to be accepted as professionals. We don't mind long hair or beards if they are neatly groomed. Although not always true, sloppy personal habits are often taken to be representative of one's work habits and performance.

In summary, we have looked at the types of communications material the writer/editor produces, the audiences for this material, the role of the writer/editor in producing this material, and the skills he must have. If we again ask the question "What are the demands of industry on the technical writer?" we must answer by saying industry expects him to be a combination salesman, writer, and leader with the stamina of a bull.

HAROLD P. ERICKSON

English Skills among Technicians in Industry

A survey to determine the English needs of technicians was taken. As a result, a two-semester curriculum was developed for teaching English to technical students. Harold P. Erickson is at Coleman Technical Institute, La Crosse, Wisconsin.

In the rapid growth of the technical, vocational, and adult schools in Wisconsin, the technical subject areas have kept pace with the constantly changing demands of industry while some of the academic areas, such as English, have had little or no revision to meet these new demands. For this reason, 379 questionnaires were sent to industries in Wisconsin, Iowa, and Minnesota to determine the English needs of the technician. In addition, fourteen interviews were conducted with businesses in Wisconsin and Minnesota. The results of this study are recorded in Tables 1, 2, and 3.

The responses indicate that between 57.2 and 69 percent of the technician's time is devoted to the use of communicative skills. They also suggest that technical reporting represents a major portion of the technician's job, and that this task is about equally divided between oral and written reporting.

Table 1. Results of Surveys

	Responses from Industrial Questionnaires			*Interviews*
Task	*Number of Responses*	*% of Useable Responses*	*Mean % of Time*	*Mean % of Time*
Business letters	86	64	6.0	10.0
Writing technical articles	53	39	11.0	00.0
Reading technical articles	129	96.9	10.1	16.7
Oral communication	127	95.4	30.1	42.3
Total time spent in communicative tasks			57.2	69.0
Total time spent in technical tasks			42.8	31.0
			100.0	100.0

Table 2. Technicians in Research Work

Task	*Responses*	*% of Useable Responses*	*Mean % of Time*
Written reporting	113	84.9	24.5
Oral reporting	93	69.9	25.4
Communicative tasks			49.9
Technical tasks			50.1
			100.0

Table 3. Desirable English Skills

Skills	*% of Responses*
Spelling	69.8
Technical report format	86.0
Reading	65.0
Vocabulary	75.4

Note: These three tables represent the results of 133 returned surveys and 14 ninety-minute interviews with companies in Wisconsin, Iowa, and Minnesota. Each company had to employ technicians in one or more of the following fields: automotive, electronics, mechanical design, air conditioning and refrigeration, and/or commercial art.

Business Letters

Table 1 shows that 64 percent of the responses indicated a mean average of 6 percent of the technician's time is devoted to business correspondence. Further discussion with the companies revealed that these business letters generally fit into three categories. First, he must be adept in composition of letters of inquiry, biddings, and requests for specifications. Since the technician is involved in development and maintenance, he must be able to communicate with interplant personnel as well as with other companies to inquire about new equipment. Secondly, the technician who works for a small company must often double as the purchaser of testing equipment or replacement parts. The letter of purchase, with its exactness and conciseness, should be included in any training program for the technician. Finally, the technician should be trained in the correct use of application letters. All of those personally interviewed and several of the written questionnaires indicated that few technical school graduates could write an acceptable letter of application.

In addition to letter writing, the personal interviews indicated that the technician spends a fair amount of time in writing interoffice memorandums, which can also be classified in the business letter category. Since the questionnaire asked only about business letters, the omission of memos could be a reason for the rather low percentage of time assigned to letter writing in the responses.

Writing of Technical Articles

39.0 percent of the responses indicated a mean average of 11 percent of the technician's time is given to the writing of technical articles for publication. On the basis of this response, it appears that this task has little significance for technicians among those industries surveyed. One reason for this may be that technical articles are generally written on topics of product research and development; therefore, this task is usually left to the engineer. Those companies that responded affirmatively had the majority of their technicians working in research and development sections.

Only one interview gave any support to the need for writing technical articles. A company that employs a staff of eighteen commercial artists and draftsmen in its art department gives them the responsibility for the editing of the company paper on technical matters. The technicians have to be able to gather information and condense it for a journalistic report. Also, the commercial artist or draftsman is involved in the preparation of sales catalogs, which requires some technical descriptive writing.

Reading Technical Articles

96.9 percent of the responses submitted reading as a vital skill for every technician. Most of the interviewees suggested an average of between 10 and 20 percent of technician time expended in reading, while the survey showed a mean average of 10.1 percent. This average reading time on the job seems rather low considering the numerous responses and as the importance of reading was stressed both in the comments and the personal interviews. Many of the firms that were interviewed indicated that the technicians were encouraged to read trade journals and product releases for specific job-related information. Also, due to the high complexity of technical vocations, there are unlimited numbers of specifications, instruction manuals, and company directives to follow and understand.

Comprehension was the key word in reading skill, rather than speed. There can be no doubt that the technician is severely handicapped if he lacks the ability to read for accuracy and understanding. Evidence of the importance of comprehension in the reading of technical material was indicated by 65 percent of the respondents who desired further training in reading for the technical graduate.

Oral Communication

95.4 percent of the companies surveyed indicated that a mean average of 30.1 percent of the technician's time is spent in oral communication. The personal interviews suggested that this estimate might be low by as much as 15 to 20 percent. During the ninety-minute interviews, it was revealed that more than 30 percent of the technician's time is taken up in oral communication.

Since the technician provides liaison between the production worker and engineer, a good portion of his time is spent in either sending or receiving oral directives. If the technician happens to be working in a mechanical design section, it is not unusual to see him discussing plans with engineers for fifteen to twenty minutes at a time. Technicians working in the plant as testing personnel keep an almost continual technical dialogue going as they report test results. Those companies that use technicians as servicemen in the various utility fields indicate that their technicians must be able to meet the public and represent the company with courteous service while being able to explain the mechanical aspects of a problem in laymen's terms.

Some rather general oral tasks cited by the respondents are the conducting of product demonstrations, sales meetings, and safety programs. Seven companies had their technicians actually staff exhibition booths at county fairs and industrial shows. Again, the ability to speak to groups of people is considered very important.

The skill of effective listening, although not listed on the questionnaire, received enough comment in both the written responses and the interviews to be mentioned in this report. Perhaps the best summary of the feelings of industry regarding this skill was explained by a respondent who concluded: "The listening aspect is most important. Communication, to be highly effective, must totally encircle sender and receiver." In the work of the technician, where thousands of dollars may be invested in each project, the ability to listen to and comprehend instructions plays a major role.

Technical Reporting

Both the comments and the interviews support the conclusion that a total of 49.9 percent of research work is spent in reporting. This is further broken into written reporting, 24.5 percent, and oral reporting, 25.4 percent. Formal or informal technical written reporting generally falls into two classifications: description and analysis. In the descriptive classification, the technician may do several possible types of work. Mr. Klaus, chief engineer, La Crosse Telephone Company, stated that reporting ability was a major factor in his company. Those technicians who perform service work away from the plant must report every line breakdown that occurs, with explicit instructions on the repair of the problem or recommendations for the next shift. In the case of the night shift, where there is often no engineer on hand, the importance of the report is increased. In most cases, this report is made on a standard form. At the end of the month the technician prepares a formal summary report ranging from one to ten pages and in which clarity, conciseness, and accuracy of language are essential.

Changes in product specifications are another source of descriptive report writing for the technician. In a large drafting and development section, each print can have as much as ten percent of its area devoted to instructions. The ability to accurately instruct the user of the print becomes as important as the print itself.

Finally, the descriptive type of reporting is present in the writing of sales brochures. A smaller company almost exclusively uses its technicians to write not only the descriptive literature of the product but also the instruction sheets and specifications for the customer. For larger products, the report may run a total of eighteen to thirty pages, while the smaller items can be easily handled in one page. Whatever the case may be, the emphasis must be on the ultimate use of the material by the consumer.

The second major category of written reports is the reporting of test analysis. This is generally done on printed report forms on which the technician is responsible for accurately reporting data he receives from the tests. Some of the larger companies that were interviewed made extensive use of computers to handle detailed work, but there were still many instances where physical tabulating and reporting were being done by the technician.

Written reporting includes not only formal research reports but also the daily reports that the specialist must perform. The amount of time spent in reporting these tasks is directly related to the role of the technician. For example, technicians employed in the research and development areas, who spend the majority of their time in pure research, have a definite need for technical writing abilities.

Another factor in report writing is the necessity for accurate spelling. The survey showed that 69.8 percent of the companies indicated a need for spelling improvement among technicians. Every interview supported this observation, and comments on the questionnaires stated that the technician's spelling ranged from "poor" to "atrocious." Personal observations showed the undesirable effect a misspelled word could have on a blueprint that is sent to a customer.

An unnamed manager summed up the entire philosophy of the written report in these words:

> An individual's work is . . . questioned if his work is sloppy, made up of obvious errors, and contains spelling errors of simple, common words. If there are errors in the written presentation, there is an inference of errors in the original work.

Oral Reporting

Approximately 70 percent of the companies indicated a mean average of 25.4 percent of the technician's time is given to oral reporting. The interviews definitely showed oral reporting to be a major factor in research work. It is nearly impossible to separate conversational reporting from factual reporting to a superior or subordinate. However, one major point to consider is the level of appropriateness in the language the technician encounters. Even though some of the oral reporting tasks he may perform are of an informal nature, he nevertheless must be able to comprehend and speak in the vernacular of all levels, from the engineer and the administrator to the worker on the line. There is further evidence in the comments on the questionnaires indicating that many industries have their own terminology; therefore, the technical graduate must be able to learn new terms peculiar to his field. Stronger preparation in the skills of basic and specialized vocabulary building were indicated in 75.4 percent of the industries surveyed.

Whereas the written report is a permanent record of the technical research being performed, the oral report is an on-the-spot report of progress being made. According to the supervisors interviewed, it is a common occurrence for a technician to be called upon to explain the progress of an experimental or developmental project before a directors' or managers' meeting. The need for training in short impromptu speeches is very apparent in this function of the semiprofessional worker.

More formal oral reporting involves the effective use of graphic materials and some training that will aid in their use and preparation is recommended. Once again, this differs with various fields, but on the whole, the technician should be able to effectively illustrate his presentation with whatever visual or communicative aids he has at his disposal.

The oral report fits the same categories as the written; that is, reports of description and analysis. The major difference is one of preparation and delivery. While the written report can be prepared, reviewed, and then rewritten, the impromptu report must be logically organized and clearly delivered on the initial attempt. Furthermore, there are distinct differences in kinds of language, color, and effect between oral and written reports.

As a result of this survey, a two-semester curriculum was developed for the teaching of English to technical students. Each semester provides eighteen weeks of instruction and practice in the various areas of language communicative skills revealed to be of importance to industry. The first semester devotes two weeks to the study and writing of effective business correspondence, with emphasis on letters of application, inquiry, and purchase. The following four weeks are given to development of reading and compositional skills. The content of the reading unit is used both for developing comprehension and for teaching the organizational skills needed for written and oral exposition. The final twelve weeks of the first semester concentrate on the development of speaking skills and methods of oral delivery. Emphasis is placed on persuasive speaking, informative speaking, small group discussion, and effective listening.

The eighteen weeks of the second semester are devoted to oral and written reporting. The unit on technical reporting is introduced with background information on types and styles of reports. Attention is directed to the various attributes of the report, such as clarity, conciseness, and completeness. Special techniques of report writing are presented, including the use of definitions, descriptions, classification, and interpretation. In brief, the entire semester of written and oral reporting is designed to implement the communicative skills of the first semester's work in preparation for the technical graduate's entrance into industry.

The entire philosophy of this English program for technical students is summarized by this remark from one of the survey respondents: "The technician who is able to speak and write well generally is able to move to a better position, simply because of the impression he makes."

EVERETT E. WALDE

A Survey to Determine the Effectiveness of a Communication Skills Course for Trade and Industrial Graduates of a Technical Vocational School

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The results of a survey of employers and employees regarding communication skills are presented, and recommendations are made for improving coursework at technical vocational schools. Everett E. Walde is Chairman of Communication Skills, District One Technical Institute, Eau Claire, Wisconsin.

Introduction

Communication is important in the life of everyone. Too many misconceptions can arise when an individual communicates with another because each individual assumes that all others attach the same concepts to the meaning of words as he does. This often becomes the basic cause of misunderstanding one's fellow man. Two people may use the same words but not speak the same language because one may be speaking technically, while the other may be merely applying a layman's meaning to the word or term. Each person tends to interpret the written or oral word according to his own set of meanings. Raymond G. Smith, professor of speech and theatre, Indiana University, says that the importance of communications cannot be underestimated and that there are various methods to aid in understanding others and in impressing the speaker's meaning on an audience. Smith recommends some of the following methods: repetition, summarization, vivid description, association of word with symbol, and tape-recorded playbacks.

As part of communications, a student in a technical-vocational school is expected to learn correct spelling, parts of speech, punctuation, sentence structure, paragraph structure, correct methods of business letter writing, and basic fundamentals of speech. This knowledge is intended to enable the student to communicate more effectively with the oral and written word. Everett C. Smith, employment supervisor for the General Electric Company, Fort Wayne, Indiana, agrees that students need these essentials of communication. Mr. Smith states that all men, regardless of their position in industry, must have enough training in communications to know how to sell their ideas to their superiors and how to get along effectively with their fellow men. Smith believes that composition is an essential element in a student's training. He feels that if the worker cannot write well, he will never advance appreciably. Communications will not solve the problem of misunderstanding between people, but it will better prepare the graduate to be aware of the problems which he will inevitably encounter and to which he must adjust.

Dr. William Watt, chairman of the English Department at Lafayette College in Eastern Pennsylvania, recognizes the need for teaching basic courses in communications. He emphasizes the need for more expository writing in which the student expresses exactly what he is thinking. Dr. Watt recommends that English teachers stay away from long themes but require their students to write one paragraph a week that "says something." He also suggests that basic grammar should be utilized more to aid the student in using words correctly as parts of speech and as portions of sentences.

Background of the Problem

Within the last two decades the name "Communication Skills" or "Communication Arts" has been used as another term for "Language Arts," or English.

Communication Skills better describes the goals of language instruction than do either Language Arts or English. Communication Skills illustrates the concept of language as a means of expressing and receiving ideas. Some broader concepts include art and music as communication media, but most instructional programs include writing, speaking, reading, and listening as chief components of communications.

At technical-vocational schools the English program contains units in spelling, punctuation, grammar, writing, reading, and listening as the basic essentials for man to express himself better in the written and oral word.

The demand for a well trained person in public relations, speaking, and personnel work has become greater through the years. Industry is periodically reminding technical-vocational schools that future employees must be trained to be effective not only in their major areas of training but also in the necessary art of communication. Robert Hays, English professor from the Southern Technical Institute, Marietta, Georgia, echoes the importance of communications to technicians and engineers. He believes that communication in some form is used and performs an essential function in the following areas of industry: 1) union industry negotiations, 2) conveying effectively results of thinking and creating, and 3) normal increase in communication as the individual's responsibility and working level rises. The technical-vocational school's job is to prepare the students so that they will be capable of reading, comprehending, and conveying their thoughts adequately.

Study Design

The purpose of this study is to evaluate the Communication Skills courses as they are currently presented in technical-vocational schools and to determine whether the training being given is adequate to meet the demands of the students' future employers.

In conducting this survey, answers were sought to the following questions:

1. To what extent is the graduate student using his communications training in writing and oral work?
2. What, if any, are the inadequacies in communication skills that the employer recognizes in graduates of technical-vocational schools?
3. Is any post-technical training in communication skills required or paid for by the employer?
4. How might the course in communications be improved?

Two hundred and twenty-one questionnaires were sent out to former students of the Eau Claire, Wisconsin, Technical Vocational School, and these students were from the following trade and industrial areas of training: air conditioning refrigeration, mechanical design drafting, and electronics. Fifty questionnaires were sent to employers who hired technical-vocational graduates.

Limitations or Scope of Study

The limitations of this study were as follows:

1. The subjects used were only those who participated in the technical program at the Technical Vocational School in Eau Claire, Wisconsin, during the three years of 1965, 1966, and 1967. However, the knowledge gained is applicable to all technical-vocational school students and graduates.

2. Only questionnaire forms limiting the amount of information available were used because of the ease in checking desired answers without reading each statement thoroughly, or because of failure to respond.

3. The survey included only former students who were gainfully employed.

4. The employers contracted were restricted to those who hired Eau Claire Technical School graduates within the three years mentioned above.

5. The total number of students and employers contracted might represent a small sampling; the number of students contracted was 221, and the number of employers contracted was 50.

Review of the Literature

Many articles have been written in a theoretical framework concerning the communication skills needs of technical students in their respective jobs after graduating from technical-vocational schools; however, while doubtless many surveys have been carried out on this subject, very few surveys related to communication skills have been reported in the literature. This is perhaps due to the fact that instruction in communication skills in technical vocational education is relatively new.

In this study, questions were asked of former students, and parallel questions were asked of their employers. The three major areas covered by the questionnaires were:

1. post-technical training in communications,
2. present use of communication skills, and
3. individual inadequacies in communications.

The questionnaires also had a section for suggestions which might improve the course as it was presented and thereby better prepared the student for his future job. It seems that most students need more training in the communication skills area, and the results of this survey and of those cited here serve to support this hypothesis.

English Skills among Technicians in Industry

Harold P. Erickson, general education supervisor at the Coleman Technical Institute, La Crosse, Wisconsin, sent 379 questionnaires to industries in Wisconsin, Iowa, and Minnesota to determine the English skill needs of the industrial technician. He also conducted fourteen interviews with businessmen in Wisconsin and in Minnesota.

The results of this survey showed that from 57.2 to 69% of the technician's time was devoted to the use of communication skills. The responses also suggested that technical reporting represented a major portion of the technician's job, and that this task was about equally divided between oral and written reporting.

English Skills in the Business Field

Everett C. Smith, employment supervisor of the General Electric Company at Fort Wayne, Indiana, conducted a survey among several business associates and asked them what percentage of their time was spent in reading, listening, talking, etc. An engineer, an education and training specialist, a superintendent, a labor relations negotiator, and a cost leader were interviewed for this survey. It was discovered that these men were using language as their tool in 75% of their activities. Following this survey, several courses to improve the employee's ability to write and speak effectively were started at General Electric Company in Fort Wayne. Everett Smith recommends that schools teach public speaking, essential grammar and sentence structure, composition, and some literature. He strongly emphasizes the fact that composition and public speaking are the most important.

Reading Improvement

James R. McNally, chairman of the Humanities Department, Academy of Aeronautics, La Guardia Airport, Flushing, New York, has been instrumental in carrying on yearly experimental research on the reading skill of the technical students entering the Academy of Aeronautics since 1961. His experiment was aimed at developing powers of discrimination in reading matter: what should be studied, what read carefully, and what scanned. For this purpose, articles were used which emphasized general reading, technical reading, narrative, journalism, charts and tables, and statistics. Students were grouped homogeneously, based on their known reading problems, and underwent a study session of 10 to 12 weeks of the first semester. Eighty per cent of the students showed a normal curve of response and success. Two-thirds of the 80% were aware that the improvements were significant and useful. Therefore, it was felt that this program should continue.

The studies cited serve to emphasize the importance of oral and written communication to people in industry and business. The previously cited studies also illustrate the fact that technical vocational schools and other schools should be more concerned with the area of communication and that the presentation of communication skills could undoubtedly be improved in all schools.

The Data

Fifty questionnaires were sent to employers of Eau Claire Technical School graduates for the years 1965, 1966, 1967. These questionnaires requested information pertaining to inadequacies of the students in communication skills and asked for suggestions to better prepare the student for industry. A sample questionnaire is attached (see Questionnaire A). Thirty-three questionnaires were returned, a 66% return.

Communications Questionnaire A

Instructions: Please place an X in the appropriate box and/or add "other" information or suggestions that seem appropriate.

I. What apparent inadequacies are you finding in technical school graduates:
   - ☐ Inadequacy in writing business letters.
   - ☐ Inability to prepare minor written reports.
   - ☐ Inadequacy in comprehension and retention. (Require several reminders of previous orders.)
   - ☐ Inability to present reports orally.
   - ☐ Apparent insecurity in interviewing others.
   - ☐ Lack of courtesy or being self-conscious when introduced to others.
   - ☐ Other

II. Suggestions for improving the "communication skills" course.
   - ☐ Continue course as currently presented.
   - ☐ Include more spelling, grammar and punctuation.

- ☐ Add reading, comprehension and interpretation.
- ☐ Emphasize sentence and paragraph structure.
- ☐ Include more business letter writing.
- ☐ Require more work in oral reading and speaking.
- ☐ Require students to do at least one research paper in their major field of interest.
- ☐ Other (explain briefly)

III. What kind of post-technical training in communications are you offering to your employees or requiring them to obtain?

- ☐ None

Paid attendance at:

- ☐ (a) a local technical school
- ☐ (b) a University or College
- ☐ (c) University extension course
- ☐ (d) Dale Carnegie or Stubenvall course in public speaking

Employees required to attend classes without receiving wages:

- ☐ In business letter writing
- ☐ In public speaking
- ☐ In public relations
- ☐ In effective interviewing and normal oral communications with fellow employees
- ☐ In report writing
- ☐ In company conducted classes pertaining to oral and written communication.
- ☐ Other

Two hundred and twenty-one questionnaires were sent to former students who attended the Technical Institute at Eau Claire, Wisconsin, for the years, 1965, 1966, 1967 (see Questionnaire B). The questions pertained to how the student was utilizing information gained from the communication skills course taken here, if he was receiving additional training in communications, and if he was lacking in skill in communications. In addition, inquiry was made regarding how the course could be changed to give more effective training to the student. One hundred and twelve questionnaires were returned, a 50% return. Approximately 5% were unanswered due to the former students' being in the armed forces.

Communications Questionnaire B

Instructions: Please place an X in the appropriate box and/or add "other" information or suggestions that seem appropriate.

I. What is your present occupation? ____________________

____

Briefly, list the main duties of this occupation. ____________

____

____

II. Post-technical training in communications
- ☐ Received training in communications
- ☐ Through college attendance.
- ☐ Through extension or correspondence courses.
- ☐ Through Carnegie or Stubenvall courses. Special training services supplied by your employer.
- ☐ Other—explain briefly. ____________________

____

III. Present use of communication skills

A. Written:
- ☐ daily or weekly reports
- ☐ interoffice memorandums
- ☐ business letters
- ☐ order forms and requisitions
- ☐ recording secretary at business meetings
- ☐ Other—explain briefly.

____

B. Oral:
- ☐ personal interviews for the company
- ☐ taking charge of business meetings
- ☐ introducing new employees to the firm
- ☐ acting as a guide for visiting executives and group touring
- ☐ placing and receiving business phone calls
- ☐ Other—explain briefly. ____________________

____

IV. What do you feel are your own inadequacies in communications?
- ☐ Difficulty in preparing reports.
- ☐ Inadequate in writing business letters.

- ☐ Punctuation and sentence structure is very poor.
- ☐ Difficulty in reading, comprehending, and retaining information.
- ☐ Embarrassment at being introduced to strangers.
- ☐ Difficulty in presenting material orally.

V. Suggestions:

- ☐ Continue administering our course as previously done.
- ☐ Include more grammar and punctuation.
- ☐ Include more spelling.
- ☐ Include more sentence structure and paragraph composition.
- ☐ Include more training in reading comprehension and retention.
- ☐ Utilize short stories as a means of studying good writing and comprehension.
- ☐ Lengthen the business letter writing unit.
- ☐ Include more basic speech and possibly interpretative reading.
- ☐ Other—explain briefly. ______________________________

A breakdown of the responses to the questionnaires is shown in Table 1 and Table 2.

Employer Response Data

As shown in Table 1, the employers rated Section 1 pertaining to inadequacies in order of importance as follows: business letter writing, 60%; preparing reports, 36%; oral reporting, 27%; interviewing others, 21%; self-conscious in meeting others, 18%; and comprehension and retention, 16%.

In Section II, dealing with suggestions for improving the course, the following suggestions were given in order of importance: provide additional instruction in reading, comprehension, and interpretation, 42%; require more oral reading and speaking, 42%; assign additional work in sentence and paragraph structure, 33%; assign a research paper pertaining to the student's major area, 33%; assign more business letter writing, 30%; review more spelling, punctuation, and grammar, 30%; continue the course without change, 3%.

Table 1. Results of Questionnaires To Employers of Eau Claire Technical School Graduates

(Percentage is based on the total number of questionnaires returned, 33)

Questions	*Responses*	*Percentage of total response*
I. Inadequacies in Technical Schools Graduates		
Writing business letters	19	60
Preparing reports	12	36
Comprehension & retention	4	16
Oral reporting	9	27
Interviewing others	7	21
Self-conscious in meeting others	6	18
II. Suggestions for Improving the Course		
Continue as is	1	3
More spelling, punctuation, grammar	10	30
Add reading, comprehension, interp.	14	42
More sentence & paragraph structure	11	33
More business letter writing	10	30
More oral reading and speaking	14	42
A research paper in major area	11	33
III. Post-Technical Training Being Offered		
A. Paid Attendance		
None	13	40
Local technical school	9	27
University or college	6	18
University extension course	10	30
Carnegie or Stubenvall course	2	6
B. Non-Paid Required Attendance		
Business letter writing	2	6
Public speaking	2	6
Public relations	1	3
Effective interviewing	4	16
Report writing	2	6
Company conducted classes	9	27

Table 2. Results of Questionnaires to Eau Claire Technical School Graduates

(Percentage is based on total number of questionnaires returned, 112)

Questions	*Responses*	*Percentage of total responses*
II. Post-Technical Training in Communications		
Received training in communications	26	23
Through college attendance	10	9
Extension or correspondence courses	6	[illegible]
Carnegie or Stubenvall courses	3	3
Training supplied by employer	20	18
III. Present Use of Communication Skills		
A. Oral		
Daily or weekly reports	55	50
Interoffice memorandums	27	24
Business letters	17	15
Order forms-requisitions	55	50
As recording secretary	2	2
B. Written		
Personal company interviews	15	14
Conducting business meetings	3	3
Introducing new employees	12	11
Guiding visitors	10	9
Using the telephone	44	44
IV. Inadequacies in Communication		
Difficulty in Preparing Reports	17	15
Business letter writing	28	25
Punctuation in sentences	32	30
Reading, comprehension, retention	14	13
Embarrassment at introductions	15	14
Presenting material orally	48	43
V. Suggestions		
Continue course as is	11	10
Include more grammar and punctuation	31	28
More spelling	22	20
More sentence and paragraph construction	36	32
More reading, comprehension, retention	22	20
Utilize short stories	15	14
More business letter writing	22	20
More speech and oral reading	46	41

Section III pertaining to required or offered attendance in post-technical communication courses reveals that 40% of the employers do not require or offer any post-technical training in communications. However, paid attendance is offered by employers as follows: to take a university extension course, 38%; to attend a local technical school, 27%; to attend a university or college, 18%; to take a Carnegie or [illegible] course, 3%. The non-paid required attendance in communications classes is as follows: company conducted classes, 27%; effective interviewing, 19%; business letter writing, 8%; public speaking, 8%; report writing, 5%; and public relations, 3%.

Technical School Graduates Data

The post-technical student questionnaires deal with parallel areas of concern; the data are summarized in Table 2. They are: (1) personal feelings of inadequacies in communications, (2) present use of communication skills, (3) suggestions for improving instruction in communication skills, and (4) post-technical training received.

In Section IV, personal feelings of inadequacies in communications, the former students rated their inadequacies in order of importance as follows: presenting material orally, 43%; punctuating sentences, 30%; writing business letters, 25%; experiencing difficulty in preparing reports, 15%; being embarrassed during introductions, 14%; having difficulty in reading, comprehension, and retention, 13%.

In the present use of communication skills, Section III, the former students rated the skills in writing in order of importance as follows: daily or weekly reports, 50%; order forms and requisitions, 50%; interoffice memorandums, 24%; business letters, 15%; secretarial recordings, 2%.

The suggestions offered in Section V to revise the course or to continue as is were in order of importance: include more speech and oral reading, 41%; include more sentence and paragraph structure, 32%; include more grammar and punctuation, 28%; include more spelling, 20%; include more reading, comprehension, and retention, 20%; include more business letter writing, 20%; utilize short stories, 14%; continue course as is, 10%.

In Section II, post-technical training received, the respondents gave the following information: received training in communications, 23%; training supplied by employer, 18%; training obtained through college attendance, 9%; training gained through extension or correspondence courses, 6%; training gained through Steubenville or Carnegie courses, 3%.

Analysis of the Data

The need for post-technical school training is recognized by the employers, as shown in Table 1. Even though 49% of the employers who responded do not require any further training in the communications area, 30% of these employers do require it and provide pay for taking university extension courses. Twenty-seven per cent provide paid attendance at a local technical school, and 18% provide paid attendance at a local university or college. While the paid attendance at a university is only 18%, or about one-fifth of the total respondents, the paid attendance for a university extension course and for attending a local technical school comprises nearly one-third of the total respondents. Company-conducted classes, utilized by 27% of the respondents, also equals almost one-third of the total number of employers who responded. The required attendance in effective interviewing, equalling 16%, is also close to one-fifth of the total responses received. Even though two of these areas equal only about one-fifth of the total responses, the other three mentioned do equal about one-third of the total responses, which seems to point to the fact that employers are concerned about the lack of communication skills in their employees, and are trying to improve this situation by offering or requiring more training in the communications area.

The parallel section of the former students' questionnaire reveals that 23% of the respondents are receiving some additional training in communications and that 20% of them are receiving training supplied by employers. While these percentages are not so high as those revealed by the employers, they are still significant because those receiving some additional communications training comprise nearly one-fourth of the respondents, and those receiving training supplied by the employer comprise one-fifth of the respondents. This shows that these students were not given enough training in the communications area to adequately prepare them for their future jobs.

The category of present use of communication skills by former students reveals that 50% of the respondents spend time in writing order forms or reports, and 24%, or nearly one-fourth of this group, are involved in preparing interoffice memorandums. This reveals the importance of writing to former technical students. Oral communications is also significant because 44% of the respondents are in situations requiring correct telephone usage. This certainly supports the need for a considerable amount of oral and written work in communication classes at the Eau Claire Technical Institute and at other technical-vocational schools.

Inadequacies in communications felt by former students reveal that oral presentation is quite important. Forty-three per cent of the respondents felt inadequate in presenting work orally. In writing, inadequacies may also be noted: 39% felt inadequate in the use of punctuation, and 25% felt inadequate in business letter writing. The inadequacies felt by former students in preparing reports, embarrassment during introductions, and in reading and comprehension were of minor nature to them because the responses all were 13% or less.

Need for Oral Work

The Eau Claire Technical Institute needs to provide more adequate training in oral work and in writing to reduce the feeling of inadequacy in presenting something orally, the feeling of inadequacy in punctuation, and the feeling of inadequacy in letter writing. Employment supervisors and educational department heads in business and industry would also agree that all technical-vocational schools need to emphasize more work in speech and in writing.

Apparently the former students are somewhat conservative in revealing inadequacies because the responses from the employers revealed somewhat higher percentages pertaining to various inadequacies in communications found in the employees. Business letter writing inadequacies, which were found by 60% of the employers, are rated higher than the former students rated this category. The former students reported that 25% of them felt inadequacies in this area. Inadequacy in preparing reports, rated by 36% of the employers, is also higher than the former students' response which was rated by 15% of them. Forty-three per cent of the former students reported inadequacies in oral reporting compared to 27% reported by employers. Apparently this area is of greater concern to the former student than to the employer. Interviewing others and meeting others is classified by the employers at 21% and 18%, which comprises about one-fifth of the respondents. The former students rated this area lower at 14%. Their concern here apparently isn't quite so great as the employers' concern is. Comprehension and retention is rated similarly on both forms. The employers' response was 16%, and the students' was 14%. This section dealing with inadequacies shows that the employers recognize inadequacies in the areas in question to a greater degree than the former students seem willing to admit. The results of this section also point to the fact that more writing and oral work should be given at technical-vocational schools in the future.

In the suggestions for course improvement, both employers and former students rated more speech and oral reading as being very important. The response from each was: employers, 42%; former students, 41%. The next section of importance—adding, reading, comprehension, and retention—was rated by 42% of the employers who responded, but this was considered important by only 20% of the former students. This may mean that the former students are either reluctant to admit needs in this area, or perhaps they don't actually realize that a need exists in reading, comprehension, and retention. The suggestion to add more sentence and paragraph structure was considered of importance by about one-third of each group. The number of employer responses was 33%, and the number of former student responses was 32%. Thirty per cent of the employers felt that more spelling, punctuation, and grammar should be added. The percentages of responses from both areas questioned are quite similar, indicating again that both employee and employer recognize the need for additional training with spelling, punctuation, and grammar. Employers are keenly aware of the need for more writing because 33% of them suggested a research paper in the student's major area, and 30% suggested more practice in business letter writing. The former students were not questioned on the value of a research paper; however, 20% of the student responses suggested more practice in business letter writing.

The former students were also asked about the value of including a short story unit in the communication skills class. Only 14% responded in favor of this. Ten per cent of the former students suggested the class be continued as it has been presented without change, and only 3% of the employers suggested that it continue as it is currently presented. These percentages are quite small in comparison to the recommended changes of both employer and former students.

In summary, it should be noted that about one-third of the employers are providing further training in communications, 50% of the former students are utilizing writing in their work, and 44% are involved in using oral skills. Sixty per cent of the employers recognize the need for more training in writing business letters, while 43% of the former students feel a need for more training in oral work. One-third or more of the responses from employers and former students emphasized suggestions to include more speech, oral reading, and writing in the course for the future. The responses in all areas of the questionnaire seem to point to the fact that more oral and written work such as speech, oral reading, grammar, punctuation, and a research paper be required in future communication skills courses offered at technical-vocational schools.

Implications of the Data to the Communication Skills Curricula at Technical Vocational Schools

As already shown, about 25% of the former students are undergoing further training in the communication skills area; some of this training is supplied by the employer, and some of it is obtained through local universities, local technical schools, or by means of correspondence extension courses.

In the use of writing skills, it was reported that 50% of the respondents spend time in writing order forms or reports, and 24% are involved in preparing interoffice memorandums. The need for good writing habits was also revealed in the former students' feelings of inadequacy. The response in this section revealed that 25% or more of the respondents felt inadequate in the correct use of punctuation and in business letter writing. The responses from the employers show even more concern in the area of writing. Inadequacies of former students in business letter writing were found by 60% of the employers, and inadequacies in preparing reports were found by 36% of the employers.

The suggestions for improving the course also support the findings of inadequacies and the present use of communication skills in the writing area. Above 25% of the responses from both former students and employers indicated that more sentence and paragraph structure, spelling, punctuation, and grammar should be added to the course in communication skills. About one-third of the employers also felt that a research paper in the student's major area would be beneficial.

At the present time the communication skills course at the District One Technical Institute, Eau Claire, is divided into the following areas of study and time allotted to each:

1. reading, comprehension retention—8 weeks;

2. writing (this unit has been designed as a basic review of parts of speech, homonyms, spelling of shop words, punctuation, simple sentence structure, and a limited amount of writing)—7 weeks;
3. listening, comprehending, criticizing—1 week;
4. speaking—2 weeks.

The writing unit, consisting of seven weeks, has in the past included the following writing assignments: one or two letters of application, a lengthy review of grammar, spelling, and punctuation, preparation of a personal data sheet or work resume, and brief summary paragraphs of films, recordings, short stories, or articles of interest in the student's major field. No research paper has been assigned in the past.

Changes in Writing Unit

Other technical-vocational schools in the State of Wisconsin are pursuing a similar course of study in their communication skills classes, and industry reports that employees are found lacking in this important area. Therefore, the results of this survey may be applicable to all technical-vocational schools that present courses in communication skills. Based on the results of the survey the following changes would seem advisable in the writing unit: 1) have the student write various kinds of business letters; 2) have the student write more descriptive paragraphs of films, stories, recordings, etc. Contingent to these changes, the following additions would also contribute to the improvement of the course: 1) besides writing descriptive paragraphs or summaries of films, short stories, etc., the student should be required to criticize the selection and comment on its good points or weaknesses; 2) short summaries of articles read in the student's major area could be required at various times during the semester, together with the student's criticism or response relating to the validity of the article; 3) a written brief or outline should be required of every speech given in class; 4) a research paper should be assigned pertaining to literature in the student's major area; this assignment should familiarize the student with procedures of research, correct usage of footnotes, correct composition of a bibliography, and correct format of the research paper.

Oral communications is of vital importance to the former student as revealed by the results of the survey which show that 44% of the respondents were involved in situations requiring telephone usage. This need is borne out by the fact that 43% of the former students felt inadequate in presenting work orally, and 27% of the employers noted inadequacies in oral reporting. More oral reading was suggested as an addition to the course by 42% of the employers and by 41% of the former students. As part of the oral program, interviewing others was of importance, too, because 21% of the employers noted inadequacies in this area.

The oral or speech unit has, in the past, consisted of approximately two weeks out of the 18-week semester. During this two-week period each student gave one oral descriptive report, and, if time permitted, a period of questions and answers and criticism followed the speeches of each class period.

Recommendations in Speech

The following changes are recommended to make the speech unit more effective: 1) oral reading should be included; 2) the students should give various types of speeches such as describing a material object or a process, explaining how-to-do-something, persuading someone to buy something, or criticizing or praising a process or idea; 3) a scheduled period of questions and answers and constructive criticism should be allowed after each talk or reading. The following additions should also be considered based on the results of the survey: 1) at least three oral readings should be required; 2) every student should give at least three speeches (of different kinds); 3) group discussions and business meetings should be added; 4) mock interviews should be conducted (at least two with each student); 5) practice in correct telephone usage should be included.

The unit on reading, comprehension, retention was rated as being important by 16% of the employers who responded and by 14% of the former students who responded. Twenty per cent of the employers suggested that more practice be given in reading, comprehension, and retention. This unit in reading, comprehension, and retention has been allotted eight weeks in the past. The student has an opportunity in this unit to read, evaluate, and criticize the author's point of view, the story or article as a whole, and to suggest the implication of the article or story to the individual. Quizzes were often administered to check the student's comprehension and retention of what he read. Dictionary use involving definition or connotation, denotation, and derivations was also a part of this unit.

The change to be recommended in reading instruction is that perhaps more articles of a technical nature relating more closely to the student's major field of interest should be used for practice in comprehension and retention. Major issues of the day in government, education, and in the humanities should also be used in an effort to broaden the student's understanding of contemporary issues and their implications toward the individual and toward society as a whole. According to the results of the survey, this unit could be much shorter, and more time should be devoted to the units on writing and speaking.

The one-week unit on listening should be retained, because this is really a part of comprehension and retention. The student must learn to listen, to take adequate and meaningful notes, and to effectively utilize the information gained. Listening and analyzing are also definite parts of the speech unit, but there are other areas such as various types of speeches, and controversial talks and readings which are not included in the speech unit. These are important to the listening unit for the student listens for different things in each different type of talk, recording, or reading.

Changes in Time

The implications of the data indicate that the various changes previously listed would be advisable, requiring the following changes in time allowed for each unit.

1. The writing unit should be left at seven weeks which comprises nearly one half of the semester in communication skills. This would seem to correspond with the results of the survey which show that 50% of the former students' time is spent in writing order forms and reports, and 60% of his time is utilized in writing business letters. The lengthy grammar review could be shortened considerably and combined with the writing stressing grammar, punctuation, and spelling only as the need for it arose during writing exercises; this would allow more time for writing business letters, analytical paragraphs, and a research paper.

2. The oral or speech unit should be changed from two to seven weeks. This suggestion is also based on the results of the survey which showed that 44% of the former students were involved in telephone usage, and 43% of the former students felt inadequacy in the oral presentation of work. Oral reading was suggested by 42% of the employers, and by 41% of the former students. These figures show that nearly 50% of all the respondents felt that oral communication was of almost equal importance to writing; therefore, it would be advisable to devote seven weeks to the speech unit in order to include the various kinds of speeches previously mentioned, oral reading,

group discussions, business meeting, telephone usage, and interviewing.

3. The reading unit should be changed from eight to three weeks. This change is based on the results of the survey which showed that less than 20% of all the respondents felt that a definite need existed for more work in reading, comprehension, and retention. This unit would still encompass reading, comprehension, and retention. Use of the dictionary dealing with definitions, connotation, and denotation would also be found in the speech and writing units.

4. The listening unit should continue as a one-week unit even though some of this material is also presented in the speech and reading units, and the results of the survey do not reveal any suggestions regarding listening; however, this unit should be somewhat separate because the student gains experience in learning to listen for different things in speeches, instructions, films, and recordings. Some of these aspects include listening for implied meanings, satire, persuasive suggestions, an intended moral, or merely to obtain the major ideas of the oral presentation.

With these changes, the communication skills class at the District One Technical Institute and at other technical-vocational schools should better prepare the student to meet the needs specified in the questionnaires received in this survey.

Conclusions and Recommendations

On the basis of the results of this survey the following conclusions may be drawn:

1. The major areas of inadequacy reported by the employer and felt by the employee are in writing reports and business letters and in oral presentation of material.

2. Approximately 50% of the respondents are involved in written and oral communication in their present work.

3. Approximately one-third of the employees are required to attend some type of communications class.

4. About 50% of the employees and employers suggested more training be given in the areas of oral speech and reading, mechanics of punctuation and sentence structure, and written work.

From these findings it seems that the Technical Institute at Eau Claire, Wisconsin, and undoubtedly other technical-vocational schools are lacking in providing the in-depth training in communications that the prospective employer needs.

Recommendations resulting from these conclusions are:

More experience in writing business letters, memorandums, and reports should be given to the students.

More work in oral reading and speech should be given to the student.

More practice in punctuation, grammar, and sentence structure should also be given.

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8

Technical Writing: The Science and the Art

THOMAS M. SAWYER

The Common Law of Science and the Common Law of Literature

Examining science and literature, the author finds that both seek answers to the same questions, and that the laws which govern both are necessary if society is to function harmoniously. Thomas M. Sawyer is in the Department of Humanities, College of Engineering, University of Michigan.

I have always felt that to construe the term "literature" as including only poetry, drama, and fiction is to narrow the definition unreasonably. Philosophy, history, and law, it seems to me, are also literary in nature and in this paper I will use the term "literature" in this broader sense.

It is easy to point out that there are differences between the modes of thought employed by persons trained in science and persons trained in literature. This distinction has been publicized as the "two cultures" by C. P. Snow and because of the recent alarm over the contamination of our water and air it has become the subject of public controversy. The controversy has produced a sort of confrontation politics in which neither party debates or discusses with the other; instead each issues demands and ultimata. On my own campus this has taken the form of demonstrations to deny engineering students access to a Dow or DuPont or General Electric recruiter and the hitting of an Allied Chemical Company recruiter with pesticide spray and dead fish. If these were only the acts of high-spirited students it might not be worth fretting about. But when the first Vice-President of the Modern Language Association is reported to have been one of a group who used a battering ram to break down the door and seize the office of President Howard Johnson of M.I.T., it begins to look like the start of a religious war. Some people from the literary culture charge those in the scientific one with heresy and accuse them of abandoning all human values. At the same time some persons from the scientific culture, such as the Nobel Laureate, Francis Crick, charge that ". . . the old, or literary culture, which was based originally on Christian values, is clearly dying . . ." and hold that the scientific culture is scheduled to replace it.

Religious wars tend to be prolonged and bitter, so perhaps it is now time to stop emphasizing the differences between these two cultures and seek some similarities between them which may serve as the starting points for negotiation and eventual cease-fire.

To begin with, science and literature are both products of the human mind; they are simply different ways in which man tries to predict the future. Science is very successful in predicting what will happen to inanimate things, less successful in predicting the behavior of living organisms, and least successful in predicting the behavior of man. Because much of man's behavior is verbal, literature and science overlap in this area of study. It is often difficult to determine whether a work dealing with the behavior of man should be considered a scientific or a literary treatise, and a dispute about its classification is often a semantic quibble. One could probably classify Oscar Lewis' *The Children of Sanchez* as naturalistic literature and Sinclair Lewis' *Main Street* as a sociological study.

Both science and literature pose the question, "What would happen if . . . ?" And both find their answers in the common law. Both turn to the past to search for precedents, for the findings arrived at in previous and similar cases. The NASA expert trying to predict the flight of his rocket turns to Newton's law of falling bodies. The dramatist or novelist trying to make his characters predictable and thus real must have them obey the common ethical law. In neither case is the common law absolute and two principles of law may contradict each other. Thus it is that the crucial experiments in science deal with events which would produce different results depending upon which of two contradictory laws hold true, and some cases may drag on through the courts for years. It has still not been decided whether light should be treated as a particle or a wave. The same holds true of the great works of literature. They also deal with crucial experiments where two different ethical laws contradict each other when applied to the same human actions

Both science and literature establish their precedents by observing patterns and regularities in phenomena. These patterns and regularities suggest that the phenomena are replicable, or repeatable, that given the same initial conditions the same events will follow in the same order and that one can now act wisely because he knows, within some penumbra of uncertainty, what will happen in the future. We sometimes phrase these patterns as proverbs to make them easy to remember. Red sky at night; sailor's delight. Spare the rod and spoil the child.

If science and literature have so much in common, why do we seem to have this division between the two cultures? It is my contention that the difficulty is primarily one of rhetoric and semantics. Let me explain more fully.

Consider the type of "What would happen if . . . ?" question that a physicist might ask. Professors C. N. Yang and T. D. Lee asked the 1957 Nobel Prize winning question, "What would happen if parity were not conserved?", if Nature were not both right-handed and left-handed, if there were no mirror images in Nature? This is not the sort of question that most of us can understand and appreciate, yet it is a profound question and one that is probably as important as Einstein's question, "What would happen if time were relative rather than absolute, if the velocity of light were the only universal and absolute constant?"

To answer his own question the physicist now constructs a deductive chain of propositions based upon the axioms implicit in his question. It is very much like Euclidean plane geometry that we studied in the eighth grade. The theoretical physicist works his way down this chain of deduction, usually resorting to mathematical symbols, because they are briefer and handier than words and sentences, until he arrives at a consequent proposition which can be tested for its validity or predictive power. An experimental test will now reveal whether his prediction is accurate or not. If not, the whole deductive chain falls apart. If accurate, he can say that his axioms are probably true. Only probably true because further propositions and experimental tests may cast doubt upon his whole theory. But until such new and exceptional cases are found, his axioms and propositions will serve as a precedent establishing the common law of his science and be used by other scientists as the basis for their own decisions and predictions.

It is fairly obvious that one cannot understand many of the most interesting questions in physics without having gone through a period of training, usually involving the study of a peculiar and esoteric terminology. It is this language barrier that creates the gap between the two cultures and the "hard" sciences, like physics, are highly mathematized and thus especially difficult to translate. As we move through the biological and into the social sciences the language becomes more like our everyday speech and thus easier to understand.

This idea of the spectrum of difficulty, or untranslatableness, of the different sciences has been pointed out by many authors. They all agree on the order and all place the physical sciences first, at the most difficult or the bottom end of the pyramid, with chemical sciences, somewhat less difficult, on the next level above, the biological sciences on the third level, then psychology, followed by the sociological sciences. Although they agree on the hierarchy, they tend to disagree about the underlying reason for this hierarchy. The French philosopher, Auguste Comte, believed it reflected an order of complexity and dependence. Physics developed first because it was the simplest science, omitting the study of chemical reactions and living organisms. Comte argued that each science on a level above must wait for the science on the level below it to provide the supporting concepts. The anthropologist, Leslie White, contends that the hierarchy is the result of ego involvement. It is much easier to be objective and clear-headed about a physical or a chemical reaction than it is to deal with a frightened child who is either physically or mentally ill. The philosopher, F. S. C. Northrop, would argue that each science grows from a stage of natural history in which it observes, describes, and classifies phenomena. Only then can it begin to develop theoretical explanations of relationships between these phenomena. And, he would argue, that physics has already passed beyond the natural history stage while the social sciences are still engaged in observation and classification.

Although I believe each of these contentions is valid, it is Northrop's later argument which for me most clearly explains why the more developed sciences are so untranslatable without prolonged training. As long as a science is in the natural history stage, it is logically compatible with art. The scientist and the artist view the world in the same way. The painter's impression or the poet's impression of a bird in flight are the same as the scientist's impression and are thus interchangeable. But now the scientist superimposes upon the world of sense impressions what Northrop calls "concepts by perception." That is, the scientist adds an abstract and symbolic meaning to what is sensed. The white-feathered creature sailing above the burbling wake of our ship becomes an albatross, one of a class of birds. A class is an abstract, symbolic idea, something added to what we can sense. And then the scientist goes even further and introduces concepts by imagination—that is, ideas we can imagine, but cannot see, hear, smell, taste, or touch. Percy Bridgman uses as an example the inside of a tennis ball. We cannot sense it, we can only imagine it. We can cut the tennis ball in half, but then we have no inside any more, merely two hemispheres with convex and concave outside surfaces. Finally, the scientist goes even further. He introduces concepts by intellection, ideas we can neither sense, nor imagine. As a nonscientist I can only hope that the concept of the non-conservation of parity postulated by Yang and Lee and demonstrated by their colleague Miss Wu may serve as an adequate illustration. I obviously cannot sense, and cannot even imagine, such a thing as antimatter which, as I understand it, is a logical consequence of their theoretical postulates.

Why does the scientist use concepts like this? He does it because he must. As I contended before, the business of science is to predict the future and to predict it accurately. A scientist simply cannot do this if he relies entirely upon data that can be immediately apprehended through the senses. To predict the future he must employ causal relationships, and one simply cannot see, hear, smell, taste, or touch a causal relationship. One can feel the sudden gust of wind on one's cheek and one can see the white bird sailing in our wake suddenly zoom upwards, but the causal connection between these two sense impressions is a logically reasoned, not a sensed, one.

The great difficulty today is that the concepts of perception, of imagination, and of intellection are simply very difficult to translate into terms that make sense to the nonscientist.

Let us turn now to literary thought. As I have already pointed out, the poet's observation and the scientist's observation are equally valid. J. Robert Oppenheimer has recorded that the first thing that occurred to him as he saw the atomic explosion he had helped to create at Alamogordo was an excerpt from the Bhagavad Gita—

> If the radiance of a thousand suns
> Were to burst at once into the sky,
> That would be like the splendor of the Mighty One . . .
> I am become Death,
> The shatterer of worlds.

But when he moves beyond the natural history stage of pure observation, the literary man goes through the same abstractive process as does the scientist. He also superimposes an abstract and symbolic meaning on what is sensed. The human beings he observes and describes become classified as butchers, or bakers, or candlestickmakers; plaintiffs or defendants; Muslims, Hindus, or Catholics. And he too introduces concepts by imagination. The man he has classified as Muslim is observed to look at the Hindu in a certain way and the author tells us the Muslim is proud, jealous, dogmatic, and vengeful. None of these concepts are the products of direct observation, they are concepts by imagination and just as surely as one cannot find the inside of a tennis ball if one cuts it open, so one cannot dissect a Muslim and find his jealousy or dogmatism or pride.

Why does the literary man use such concepts? For exactly the same reason the scientist does: to create a deductive system which will enable us to predict what will follow when men act toward other men in a specified way in a specified situation. And the deductive system of the man of literature is subject to the same test for validity as the deductive system of the scientist. Put to the test of actuality, is the prediction accurate? It would seem to me that Lord Brougham predicted accurately in 1828 when he said, "Education makes a people easy to lead, but difficult to drive; easy to govern, but impossible to enslave." His statement, of course, is based upon much earlier precedents, like Epictetus' "Only the educated are free."

From such predictions we gradually evolve an ethical system, beginning with folk wisdom like proverbs at first, later becoming formalized in school-taught precepts, and ending in moral commandments, explicit laws and political constitutions. This complex system requires nearly as much training to understand as the system of the physicist. The essential difference is that the terminology is probably more familiar.

Given now a human situation, one turns to the precedents of common law for a decision about how to act. What should one do when one's prodigal son admits his error and returns to the bosom of his family?

But like the common law of science, there are contradictory principles of ethical law. It is when such principles collide that we have the crucial experiments of the literary culture. This is why we remember Oliver Wendell Holmes' decision in *Schenck versus The United States* where the ethical principles of the First Amendment's guarantee of freedom of speech collided with the principle of the government's right to protect itself from subversion. This is why we remember Maxwell Anderson's *Winterset* and his Mio caught between the colliding principles of truth and love. And Othello caught between love and honor, and Hamlet caught between vengeance and sin.

We need both the common laws of the scientific culture and the common laws of literary culture if we are to live wisely and fruitfully. The father of British common law, Sir Edward Coke, knew of no distinction between them when he wrote in the time of Shakespeare—"The common law is the best and most common birthright that the subject hath for the safeguard and defence, not only of his goods, lands, and revenues, but of his wife and children, his body, fame and life also."

And the father of the theory of relativity, Albert Einstein, wrote:

> For pure logic all axioms are arbitrary, including the axioms of ethics. But they are by no means arbitrary from a psychological and genetic point of view. They are derived from our inborn tendencies to avoid pain and annihilation, and from the accumulated emotional reaction of individuals to the behavior of their neighbors.
>
> It is the privilege of man's moral genius, expressed by inspired individuals, to advance ethical axioms which are so comprehensive and so well founded that men will accept them as grounded in the vast mass of their individual emotional experiences. Ethical axioms are found and tested not very differently from the axioms of science. . . . Truth is what stands the test of experience.

JOHN STERLING HARRIS

Metaphor in Technical Writing

Metaphor is omnipresent in technical language, states the author, who provides examples of metaphorical terminology commonly used in scientific and technological fields and presents generalizations about the usage of such terminology. John Sterling Harris is in the English Department, Brigham Young University.

Probably every technical editor or teacher of technical writing has encountered the argument that the use of metaphor in technical writing is unscientific. The argument runs, that while metaphorical language is acceptable in poetry and novels, the sciences and technology, which provide the subject matter for technical writing require more exact and less artistic forms of expression.

Yet such an argument must ignore both past and present practice in technical writing. It must also ignore the essentially metaphorical basis of language itself as well as the very utilitarian value of metaphor in technical writing.

(Let me here clarify that here when I say *metaphor*, I am using the word in its broad sense to include all forms of figurative language that describe things in terms of something else.)

The practice of using metaphor for technical terms is an old one and is not the invention of a modern English speaking world. For example, we call the bones of the inner ear the hammer, the anvil, and the stirrup. Those are the common and unscientific names for them, and the names function well because those tiny bones are indeed shaped like a hammer, an anvil, and stirrup. Those are metaphorical names. If we were to be scientific, however, we would call them by their precise Latin names, *malleus, incus,* and *stapes*—which in Latin, mean hammer, anvil, and stirrup.

Similarly, the navicular bone of the foot is predictably boat-shaped. And a serrate leaf has edges like saw teeth and an ovate one is shaped like an egg. The Latin names, of course, are derived from the Latin names for saw and egg.

This pattern of making metaphorical terms runs through the entire biological science nomenclature of plant and animal anatomy—from sigmoid colon to mons veneris and from deltoid muscle to Achilles tendon, and the terms are sometimes poetic and allusive as well as strictly technical.

Still, those are biological sciences, and they embody an older, perhaps unscientific tradition with their Latin associations—a tradition we would expect to appear less commonly in the physical and engineering sciences that are much more free of the Linnaean terminology. Yet even in the physical and engineering sciences, the tradition of metaphorical terminology is pervasive. For example consider the metaphors of shape that are commonly based just on the letters of the alphabet.

A frame
C clamp
D ring
F head engine
H beam (in structural engineering)
I beam (also in structural engineering)
J stroke (in canoe paddling)
L head engine and also pipe el (overlapping *elbow*)
N strut (the interplane strut on old biplanes)
O ring
P trap (in plumbing—the name comes from the shape not the function)
S curve, hook, etc.
T bolt, lug, slot, head engine, etc.
U bolt, turn, etc.
V block, cut, groove, brace, etc.

X brace
Y pipe
Z section, cut

Note that these are all in the same calligraphic pattern as *deltoid, sigmoid* and even *cuneiform*.

Or consider the wealth of metaphorical terms that apply to the automobile which has brake drums and brake shoes. That same car becomes an animate object when its gears have teeth and its carburetor has a throat—a throat incidentally which may be throttled or choked (or in Australian usage strangled)—either one by means of a butterfly. The engine may cough and sputter and die or we may kill it—with little remorse. Yet the opposites sound either a bit too trite or poetic—"the engine roared into life or came alive," and there exists no transitive metaphor to replace *start*. That is, we cannot quicken or enliven an engine and certainly can't give birth to one.

The list could go on and on from fuel pump *diaphragm*—which comes from a Greek word for a barricade—to a *shifting yoke* and *clutch fork* (and plate).

Here some relationships with the poetic metaphor need to be shown. A metaphor in poetry is often a concrete image of some abstract concept. If it is an apt metaphor it conveys a vigorous image—at least the first time or few times it is heard. Then it begins to wear upon the listener and he hears it as trite, hackneyed and tiresome. The "bat out of Hell" no longer conjures up images of black flying chiropter out of the nether regions, but the expression simply becomes empty filler.

But the technical metaphor does not have the same requirements of transcendency that poetry has, and beauty is not its prime parameter. Instead of becoming trite, it becomes standard terminology and as such eventually loses its metaphorical sense. For example, a *dial* was originally a sundial. From there it became the dial of a clock or watch. From that it became the indicator face for any readout. It was originally circular or semicircular, but it remains a "dial" even if it is linear—as are many radio dials. It became a verb with the telephone dial, and we still continue to "dial" with a push button phone.

This loss of metaphorical sense sometimes necessitates a re-metaphorizing. For example *manufacture* originally meant "to make by hand" then "to make" and finally to make by machine. So that with our current rage for nostalgia and craftsmanship, non-manufactured goods are "hand made." Or, a *machine* which originally meant a pulley or a contrivance or box (according to which philologist you follow) became any kind of a device. But the electronic engineer found it necessary to re-invent the idea with the black box concept—an obvious *deus ex machina*.

Another example of the loss of metaphor concept can be seen in returning to the automotive metaphors. The brake drum obviously was so named because it resembled a small snare drum. When brake *shoes* were developed to push against the inside of those drums their name referred partly to shape, partly to function. But the composition material riveted or bonded to them did not become soles or half soles but *linings*, since such material had been used as a lining for the compressive bands which had gone around the outside of brake drums in older models. Thus, the metaphorical sense was lost almost as soon as the term was invented.

Despite this loss of metaphorical sense, the metaphor remains an immensely practical way to convey certain kinds of information. If directions say to turn a wheel to the left we may arbitrarily assume that it means the top rim is to move to the left, even though the bottom rim moves to the right. The metaphorical counter clockwise (or as the English say *anti-clockwise*) is certainly clearer. And since orientation and shape are two of the most difficult of concepts to convey with words, these are the concepts most often described with metaphor.

Consider this passage from Asimov's description of the bonds of the carbon atom. Here he extends his metaphor until it becomes a veritable technical allegory.

> Van't Hoff and Le Bel now suggested a three-dimensional model in which the bonds were directed in two mutually perpendicular planes, two in one plane and two in the other. A good way to picture this is to imagine the carbon atom as standing on any three of its bonds as legs, in which case the fourth bond points vertically upward. . . . If you suppose the carbon atom to be at the center of a tetrahedron (a four-sided geometrical figure with triangular sides), then the four bonds point to the four vertexes of the figure. The model is therefore called the "tetrahedral carbon atom."
>
> Now let us attach to these four bonds two hydrogen atoms, a chlorine atom and a bromine atom. Regardless of which atom we attach to which bond, we will always come out with the same arrangement. Try it and see. With four toothpicks stuck into a marshmallow (the carbon atom) at the proper angles, you could represent the four bonds. Now suppose you stick two black olives (the hydrogen atoms), green olive (chlorine), and a cherry (bromine) on the ends of the toothpicks in any order. Let us say that when you stand this on three legs with a black olive on the fourth

> pointing upward, the order on the three standing legs in the clockwise direction is black olive, green olive, cherry. You might now switch the green olive and cherry so that the order runs black olive, cherry, green olive. But all you need to do to see the same order as before is to turn the structure over so that the black olive serving as one of the supporting legs sticks up in the air and the one that was in the air rests on the table. Now the order of the standing legs again is black olive, green olive, cherry.

Asimov, of course, is employing a nonce metaphor, but a great many wry or fanciful applications have become solidly part of technical language. One of my job responsibilities requires that I instruct secretaries in the use of recording equipment, and they invariably believe I am putting them on when I talk about male and female electrical plugs of several varieties. They still only half believe when I explain that the same terms are applied to pipe fittings and to casting molds, and that the terms have nothing at all to do with grammatical gender, but are only following an ancient metaphorical tradition probably begun by some nameless but poetical and slightly disreputable plumber in medieval times.

Nor is that metaphorizing a dead impulse in technology. When Bobeck developed the concept of using magnetic domains in solid materials as memory devices, he christened them *magnetic bubbles,* and there was born a whole new technology with its own metaphorical terminology of *angelfish circuits, rotating t bars* and *bubble eaters.*

Even computer programmers, who seem to speak only to each other, break from their usual acronyms and anagrams to use metaphors like *word, bit, queue,* and *address.* They further talk of *awakening processes* and *putting processes* to *sleep* or even putting them in *daisy chains.*

The omnipresence of metaphor in technical talk and writing is thus easy to demonstrate but some generalizations about such uses still need to be made:

1. Metaphor is basic to language (as Emerson pointed out long ago in *Nature*).

2. Metaphor is an obvious choice for explaining such difficult spatial concepts as shape, size, texture, etc. (Thus a *male dovetail* probably gives a stronger image to the reader than does a "protruding trapazoidal prism.")

3. The poetic requirement of freshness for metaphor is in technical writing irrelevant. (If the paint is said to have an "orangepeel finish," the picture is clear, even if the metaphor is not original.)

4. The poetic ambiguity—the essential duality of artistic usage—must be regarded as foreign to technical metaphor. Thus, that dovetail must clearly relate only to shape and the resultant mechanical interlock made possible by that shape. There must be no implied aviary lightness or overtones of peace conveyed by the word.

5. Even the nonce coinage of a metaphor must be regarded as a possible permanent usage. Indeed that is how many technical terms were born.

WALTER JAMES MILLER

What Can the Technical Writer of the Past Teach the Technical Writer of Today?

Passages from the works of technical writers of the past are presented and discussed by the author, who states that from a study of the classics an aspiring technical writer can learn organization, approach, and variety of forms, especially in defining and describing process, apparatus, and theory. Walter James Miller is in the Department of English, New York University.

In discussing the question of what we can learn from the "technical writer" of the past, I do not propose to take you on one of those outline-of-history tours which quickly become foggy blurs of names and dates. Anything like a detailed history of technical writing would involve a discussion of so many literary works that most of them would—at least in the time allotted to us here—get mere mention in passing. Worse yet, a thorough historical study would involve consideration of many technical writings that have exerted tremendous historical and social influence but have enjoyed very little intrinsic literary merit.

For example, we would be considering Dr. Frederick W. Taylor's "Scientific Management" which, it is true, revolutionized American managerial philosophy and techniques; Benjamin Garver Lamme's

"Electrical Engineering Papers" which, it is true, organized electrical engineering into teachable structures of ideas; and the 1798 edition of "Encyclopaedia Britannica" which, it is a fact, was the working Bible of early American applied science. But all of these works hold no literary interest for the technical writer today, except to drive home, *ad nauseam,* the point that he can accomplish miracles simply by working from a good outline. The history of scientific and technical writing is replete—like the history of the literatures of esthetics and music—with numerous works valuable for their content, important to their day, but very, very feeble in literary quality.

No, for our needs it would be wiser to consider only the highlights—or even only some of the highlights—of the history of scientific and technical writing. Given, then, all the historical studies and translations by Drachman, Hoover, Herschel, Shapley, Finch, the Newcomen Society, Miller and Saidla, to name a few, we ask simply, "What comes out of these researches that is of value to the man more interested in writing than in history?"

To work toward an answer, and to spark our discussion, I shall limit myself to twelve important writers, dating from ancient times to now, each important not only for what he said, but for how he said it. And by limiting myself in this manner, I shall be able to illustrate my discussion of literary techniques with meaty quotations, so that we may appreciate some of the literature as well as some of the history. And, for my conclusion, I hope to garner some lessons that we can learn from these classic works. In other words, I hope to sell these authors to you, to excite you to read them more thoroughly at your convenience.

In selecting writers to make my points, I shall go back over the main line of descent of the modern American technical writer. Like any American writer, our technical writer is descended from the British, tracing his literary ancestry back to the Continent and thence to the ancient world. Starting at that far end, then, I shall talk about Vitruvius and Frontinus, as representative of ancient technical literature; Biringuccio and Agricola, as representative of Renaissance Italian and German literature; Smeaton, McAdam, and Rankine, as representing early British technical writing; Eads and Wellington, early American; and Hoover, Ammann, and Raymond, contemporary American.

One might protest the absence of Archimedes, Francis Bacon, Hugh Miller, Charles Darwin, or Albert Einstein. I would reply that these writers are already familiar to us, and that I want to make my points while introducing you to relatively unknown, still unappreciated, but also important figures in the history of technical writing. Further, I want to make my points in terms of writers in the applied sciences, a field in which most technical writing is being done today and in which the problems of raising the literary level are most urgent.

1. Vitruvius

The first important technical writer that history commends to our attention is Marcus Vitruvius Pollio, architect in the service of Augustus Caesar. In about 27 B.C. Vitruvius faced a literary problem slightly greater than that faced today by a technical writer preparing a manual on the maintenance of an IBM machine. Vitruvius was assigned to write a treatise for the master builders of Rome, to provide them with a thorough theoretical and practical guide to city planning, civil and military structures, interior decoration, hydraulics, instruments, tools, machines, engines, and all known related subjects. His "Ten Books on Architecture" served as the authority for generations of Romans and their descendants, including Leonardo da Vinci, and was still consulted eighteen centuries after it was written by such prominent engineers as the Englishman, Thomas Telford.

Of course, on such topics as the nature of materials, Vitruvius is now out of date, but it is astonishing how much he can still teach us about writing. He employed successfully all the literary devices known to the conscientious author. Let us read, for instance, a few sentences from his eloquent description of the profession of architecture:

> The architect should be equipped with knowledge of many branches of study and varied kinds of learning. . . . This knowledge is the child of practice and theory. Practice is the continuous and regular exercise of employment where manual work is done according to the design of a drawing. Theory . . . is the ability to demonstrate and explain the productions of dexterity on the principles of proportion.

Several hundred words later he sums up thus:

> since this study is so vast in extent, embellished and enriched as it is with many different kinds of learning, I think that men have no right to profess themselves architects hastily, without having climbed from boyhood the steps of these studies and thus, nursed by the knowledge of many arts and sciences, having reached the heights of the holy ground of architecture.

Note, first of all, the excellent use of metaphor, ranging from the simple "knowledge is the child of practice and theory" to the reverential "heights of the holy ground of architecture." Note, too, that Vitruvius buckles down in as early as his third and fourth sentences to definitions of such easily-taken-for-granted terms as "theory" and "practice."

Flipping a few pages into the technical treatise proper, I read:

> The town being fortified, the next step is . . . the laying out of streets and alleys with regard to climatic conditions. They will be properly laid out if foresight is employed to exclude the winds. . . . Cold winds are disagreeable, hot winds enervating, moist winds unhealthful. We must, therefore, avoid mistakes and beware of the experience of many communities. For example, Mytilene in the island of Lesbos is a town built with magnificence and good taste, but its position shows a lack of foresight. In that town when the wind is south, the people fall ill; when it is northwest, it sets them coughing; with a north wind they do indeed recover but cannot stand about in the streets owing to the severe cold.

Could there be, in all the literature of technics, a better example of a good example?

Let me make my final points about Vitruvius from his well-moulded description of pozzolana cement:

> There is a kind of powder which from natural causes produces astonishing results. It is found in the neighborhood of Baiae and around Mount Vesuvius. This substance, when mixed with lime and rubble, not only lends strength to buildings of other kinds, but even when piers of it are constructed in the sea, they set hard under water. The reason for this seems to be that the soil on the slopes of the mountains in these neighborhoods is hot and full of hot springs. This would not be so unless the mountains had beneath them huge fires of burning sulfur or alum or asphalt. So the fire and the heat of the flames, coming up from far within the fissures, make the soil there light, and the tufa found there is spongy and free from moisture. Hence, when the three substances, all formed on a similar principle by the force of fire, are mixed together, the water suddenly taken in makes them cohere, and the moisture quickly hardens them so that they set into a mass which neither the waves nor the force of the water can dissolve.

In all his descriptions Vitruvius manages to communicate his wonderment, his excitement over the materials with which he works. But in his excitement he never forgets the needs of his reader. He says, later on:

> There will still be the question why Tuscany, although it abounds in hot springs, does not furnish a powder out of which, on the same principle, a wall can be made which will set fast under water. I have therefore thought best to explain how this seems to be, before the question can be raised.

In his careful anticipation of questions likely to occur to his reader, in his use of functional metaphors, timely definitions, superb examples, and in his descriptions which catch the technical man's love of his art, Vitruvius is truly an inspiration even to the technical writer of 1961.

2. Frontinus

Another Roman who can, across centuries, give us perspective on our writing problems is Sextus Julius Frontinus. When he took over as water commissioner of Rome in 97 A.D., he found himself to be heading a department wallowing in sinecure and graft, while 40 per cent of the water supply was lost or stolen, new conduits were in disrepair, some aqueducts were bringing contaminated water into the city, and the most crowded sections were suffering droughts. As further evidence of low morale and inefficiency in his department, he discovered that there were no adequate plans of the works, no comprehensive treatise on the operation and administration of the water system.

Then in his sixties, Frontinus rolled up his sleeves. In a few years Rome's water supply was doubled, its water and even its air were purer. Water engineers worked from master plans and from an excellent information report prepared for them by Frontinus. Head found himself in a situation in which he sensed the need for—and apparently invented—this (now indispensable) technical genre, the *information report*. In his "Aqueducts of Rome" he tackled some of the timeless problems of this type. For example, he knew what many technical writers still do not know, that readers of reports will differ tremendously in the degree and extent of their technical background and interest, that some readers want only a general picture, while others want to luxuriate in details. And so, the considerate Frontinus set up alternate routes through his report, advising the less technical-minded readers when and how they could make a quick detour around a jungle of thorny data.

In style Frontinus is equally imaginative. His metaphors are bolder, more concrete than those of Vitruvius. He sees water rushing in from the aqueducts and slowing down in the catch-basins as "taking fresh breath . . . after the run." He sees his assistants as "but the hands and tools of the directing head." Uninhibited by modern "objectivity," he can, first of all, spice his work with sly sarcasm, usually at the expense of administrators less conscientious than himself. Note here how he plays it absolutely dead-pan:

> I deem it of the greatest importance to familiarize myself with the business I have undertaken. For . . . there is nothing so disgraceful for a decent man as to conduct the office delegated to him, according to the instructions of assistants.

He can, secondly, indulge in pride in his work, as when he looks at his 240 miles of aqueducts and observes, smugly:

> With such an array of indispensable structures carrying so many waters, compare if you will the idle pyramids or the useless though famous works of the Greeks!

3. Biringuccio

For fifteen centuries after these Roman works were composed, we find very little technical writing of interest to us; science and technics were, during the Middle Ages, in relative disrepute, and hence, comatose. As a matter of fact, when technical books were first printed in the early Renaissance, publishers had no contemporary manuscripts of any significance on hand, and Vitruvius and Frontinus were the best sellers, both in Latin and in translation.

The earliest significant works in modern technical literature, from our point of view at least, were in the fields of mining and metallurgy. During the sixteenth century, manuals on digging, smelting, and alloying were in great practical demand. Competition among authors helped produce, finally, two superior books still of interest to us today.

In 1540 Vannoccio Biringuccio published "De La Pirotechnica," a work instructive to us for the way in which enthusiasm and love of subject can permeate the most technical information. Some moderns would say that Biringuccio's enthusiasm has gone too far, because to his eager chapters on the fires of metallurgy he added an eager chapter on the fires of love, "the fire," he observes, in one of my favorite sentences in all western literature, "that consumes without leaving ashes."

Obviously Biringuccio was writing before narrow specialization set in, before the technical man saw any separation between work and life. But it is precisely in this that Biringuccio, it seems to me, has an important message for the modern technical writer. Biringuccio could write with passion about metallurgy because he did not confine his passion to metallurgy.

4. Agricola

The other writer of this period still qualified to teach us something about the writing craft is Georgius Agricola, a German medical doctor who wrote voluminously on the plague, weights and measures, geology and other subjects. His *magnum opus* was "De Re Metallica," published in 1556, which reigned as the standard text on the mining and working of metals for nearly two centuries. For us this treatise is itself an inexhaustible mine of good examples of technical description and scientific argumentation.

In most of his descriptions of apparatus Agricola uses the simple but dramatic techniques of starting with a small central part—a stick or a brick—and adding to it piece by piece, until gradually the static structure, *e.g.*, a hauling machine or a furnace, is a scene of activity, giving off its working noises, smells, and results. Agricola was well aware of the value of sense appeal, especially in describing a process. Notice how important are the cues for hand, eye, and ear in this passage:

> first of all they hew out the rock of the hangingwall or of the footwall if it be less hard, then they place timbers set in hitches in the hanging or footwall, a little above the vein, and from the front and upper part, where the vein is seen to be seamed with small cracks, they drive into one of the little cracks one of the iron tools I have mentioned; in each fracture they place four thin iron blocks, and in order to hold them more firmly, if necessary, they place as many thin iron plates back to back; next they place thinner iron plates between each two iron blocks, and strike and drive them by turns with hammers, whereby the vein rings with a shrill sound; and the moment when it begins to be detached from the . . . wall rock, a tearing sound is heard. As soon as this grows distinct the miners hastily flee away; then a great crash is heard as the vein is broken and torn and falls down.

To his exploitation of the five senses, add another reason for admiring his descriptions. Although Agricola's book was illustrated with hundreds of woodcuts, he rarely referred to them in his text and never depended on them to make his point. He accepted the full literary challenge of making his writing a self-explanatory medium.

In his writing Agricola could build an idea as easily as he could build a furnace. His defense of the metallic arts, with which he opens his book, is one of the great intellectual efforts of science in its struggle against ignorance and superstition. It ranks with the best defenses in modern literature of evolution and vivisection. Agricola sympathetically entertains, even forcefully restates, each argument of his opposition (*e.g.*, "it is contrary to Nature to dig up what God has concealed") before he answers it with patience and often with cleverness ("then why fish?").

After pulverizing his enemies' arguments with logical analysis, he caps his defense with a description of man without metals, inept and inhibited in farming, sewing, building:

> If we remove metals from the service of man, all methods of protecting and sustaining health and more carefully preserving the course of life are done away with. If there were no metals, men would pass a horrible and wretched existence in the midst of wild beasts; they would return to the acorns and fruits and berries of the forest. They would feed upon the herbs and roots which they plucked up with their nails. They would dig out caves in which to lie down at night, and by day would rove in the woods and plains at random like beasts, and inasmuch as this condition is utterly unworthy of humanity, with its glorious and splendid natural endowment, will anyone be so foolish or obstinate as not to allow that metals are necessary for food and clothing and that they tend to preserve life?

To his successful techniques of exposition, add still another technique instructive to us—his technique of research. Agricola was one of the first technical writers to stuff his pride and university degrees into his pocket and to interview the working technician for what he could contribute.

5. Smeaton

Nothing comparable to these works appears in the English literature of applied science for many generations. For the Renaissance reached England, on Europe's edge, last. English was the last major European language to produce a translation of Vitruvius.

In 1754, when the distinguished scientist John Smeaton decided to specialize in engineering, he could not find enough systematic writing in English to educate himself. He had to learn French and study the Continental masters. But Smeaton remedied this situation. After a long life of work on canals, mills, and engines, he undertook to rewrite his reports and notes into organized commentaries. His "Narrative of the Building of the Eddystone Lighthouse," planned as the first of a series of narratives, appeared in 1791. After his death, his colleagues carried out his project as best they could, publishing his "Reports" and "Papers" in four fat volumes. Smeaton's five books covered such a great range of problems and projects that they served as textbooks for a generation. Smeaton had founded the English literature of engineering.

His "Reports" are famous for the way he discusses profound technical subjects in the simplest language. His "Narrative" develops an epic adventure in warm, poetic language. Smeaton elicits sympathy, creates suspense, as he describes his struggle to root his lighthouse on the notorious reef, and describes his feelings when his ship is lost in a storm, his workers balk, his writing humbles him with its difficulties. But metaphor and analogy come readily to him. Stone set in the frame of a building acts "like the ballast of a ship." The narrowness of a building's base "rounds it like the rockers of a cradle." And, if he does not plan carefully, building the Eddystone Lighthouse will be like "the rolling of the stone of Sisyphus."

His planning and his efforts to explain his planning to his reader develop partly in terms of a poetic, but nevertheless scientific, analogy. Here is a portion of his account of how he conceived the proper shape for a stone lighthouse:

> On this occasion, the natural figure of the waist or bole of a large spreading oak presented itself to my imagination. Let us for a moment consider this tree: suppose at twelve or fifteen feet above its base, it branches out in every direction, and forms a large bushy top. . . . This top, when full of leaves, is subject to a very great impulse from the agitation of violent winds; yet partly by its elasticity, and partly by the natural strength arising from its figure, it resists them all, even for ages, till the gradual decay of the material diminishes the coherence of the parts, and they suffer piecemeal by the violence; but it is very rare that we hear of such a tree being torn up by the roots.
>
> Let us now consider its particular figure. Connected with its roots, which lie below ground, it rises from the surface thereof with a large swelling base, which at the height of one diameter is generally reduced by an elegant curve, concave to the eye, to a diameter less by at least one-third, and sometimes to half of its original base. From thence its taper diminishing more slow, its sides by degrees come into a perpendicular, and for some height form a cylinder. After that a preparation of more circumference becomes necessary, for the strong insertion and establishment of the principal boughs, which produces a swelling of its diameter.
>
> Now we can hardly doubt but every section of the tree is nearly of an equal strength in proportion to what it has to resist; and were we to lop off its principal boughs, and expose it in that state to a rapid current of water, we should find it as much capable of resisting the action of the heavier fluid, when divested of the greatest part of its clothing, as it was that of the lighter when all its spreading ornaments were exposed to the fury of the wind; and hence we may derive an idea of what the proper shape of a column of the greatest stability ought to be, to resist the action of external violence. . . .

Thus, the now classic torso of the stone lighthouse evolved in an extended comparison.

6. McAdam

The next British writer recommended as a stimulating influence for the modern is Thomas Loudon McAdam. The United States, incidentally, might have claimed him as one of its major writers and practitioners in applied science if it had not been for the intolerance of those New Yorkers who, after the American Revolution, just could not make the Tory McAdam feel at home on this side of the Atlantic. And so he macadamized the roads of Britain and Europe first, America welcoming his system long after it had unwelcomed its inventor.

McAdam's best work is his classic "Remarks on the Present System of Road-Making," which contains the crux of the McAdam theory. The function of a road is not, as his predecessors had believed, to carry the traffic. Rather, the purpose of a road is to keep the ground beneath it dry so that the earth itself can bear the burden. Note how again metaphor helps make the writer. A McAdam road, he says, is "a roof." His competitors' roads are "reservoirs for water."

McAdam's writing is just like the original McAdam road. His words are sharp, angular stones, pressed together into a hard smooth surface, easy to travel on, and leading swiftly to the goal.

7. Rankine

Probably the greatest applied-science writer in the English language was William J. M. Rankine. In 150 papers and four treatises he transformed engineering from an art to a science. Organizing, and in some areas creating, its theory, he treated it on the highest philosophical, mathematical, and scholarly level it had so far reached. For this reason, he was ridiculed by the giants of the "rule of thumb" era. Nevertheless, Rankine's books enjoyed a phenomenal career. The 13th edition of his "Manual of the Steam Engine and Other Prime Movers" was published in 1891, the 23rd edition of "Manual of Civil Engineering" in 1908, and the 21st edition of "Manual of Applied Mechanics" in 1921, 63 years after initial publication.

Reading Rankine today is still one of the supreme experiences in logical development of ideas. With unerring syntax, he handles ponderous masses of material in elegant fashion.

He is especially instructive in his masterful definitions. Whether defining a basic part of an engine, or dismantling a fallacious concept and building a correct one in its place, Rankine achieves a clean, simple, inevitable pattern of language. This is typical of hundreds of his now classic definitions of components of machinery. Note how he makes us visualize the components before he gives them names—the inductive and more suspenseful approach:

> The part of a heat engine in which the fluid performs work consists essentially of an enclosed space whose volume is capable of being alternately enlarged and contracted by the motion of one of its boundaries. The enclosed space is of a cylindrical form, in all engines that are extensively used in practice; and it is called the *cylinder,* even in those exceptional engines in which it has some other figure. Its movable boundary is called the *piston,* and is usually a cylindrical disc fitting the cylinder in which it moves to and fro in a straight line. In some . . . engines the piston has other forms, but its action always is to increase and diminish alternately the volume of a certain enclosed space.

His greatest definition, very important in the history of ideas, is given in this famous passage:

> In the history of mechanical art two modes of progress may be distinguished—the *empirical* and the *scientific*. Not the *practical* and *theoretic,* for that distinction is fallacious: all real progress in mechanical art, whether theoretical or not, must be practical. The true distinction is this: that the empirical mode of progress is purely and simply practical; the scientific mode of progress is at once practical and theoretic.

In this sharp rearrangement of hitherto fuzzily focused concepts, he follows through with a fuller discussion of each mode, and finally giving excellent historical illustration by contrasting Smeaton's empirical work on the old-type steam engine with Watt's great scientific advance. It adds up to one of the most successfully sustained and extended definitions in the English literature.

The modern technical writer, discouraged by the endless chore of definition, will find Rankine's numerous variations in approach an endless source of inspiration.

8. Eads

Through such works as the "Encyclopaedia Britannica" and McAdam's "Remarks," British technical writers exerted tremendous influence on early American practice. But by mid-nineteenth century the relation between the old country and the new was one of reciprocal influence. For example, American contributions to the theory of structures made by Squire Whipple and Herman Haupt found their rightful place in Rankine's syntheses of applied science. Soon American literature, with writers like James B. Eads and Arthur M. Wellington, was impressing a world-wide audience.

In 1868 Captain Eads turned a great defeat into a great triumph, mainly through his literary ability. His St. Louis River Bridge project had suffered every setback: floods, timid financing, opponents willing to exploit popular fear. When the bridge seemed just about doomed, Eads composed a magnificent 58-page report explaining, in the first part, "the plan of the structure, the principles involved in its construction, and reasons for its preference," avoiding "all technicalities not understood by every one." But in his second part he gave "all the scientific data, principles and formulae" in a way calculated to satisfy "the most critical engineer." We have here an early example of an excellent literary device for satisfying the needs of a mixed audience, now known as "the double report form." It is a more satisfactory solution than Frontinus' detour.

Debating in the best of Agricolan tradition, Eads neatly demonstrated why an arch was cheaper than a truss, and then dismantled his opposition's claim that "there was no engineering precedent for a span of 500 feet." First he showed that there had been spans of such length—his opponents had counted on popular ignorance of this—but, not willing to win on the basis of facts alone, Eads now bore down to the bedrock of principle:

> Suppose there had not been any engineering precedent? Must we admit that because a thing never has been done, it never can be, when our knowledge and judgment assure us that it is entirely practicable? This shallow reasoning would have defeated the laying of the Atlantic Cable; the spanning of the Menai Straits; and left the terrors of the Eddystone without their warning light. The Rhine and the sea would still be alternately claiming dominion over one-half the territory of a powerful kingdom, if this miserable argument had been allowed to prevail.

Financiers and engineers everywhere read the Eads report. Scientific publications praised it. Public confidence was rewon.

Even today, reading Eads is a boost to the morale of the writer who despairs over the task of translating scientific information into public action.

9. Wellington

On this side of the Atlantic the first major work in technical writing was "The Economic Theory of the Location of Railways," published in 1887, by Arthur M. Wellington. Principles set forth in this 930-page treatise have become part of the modern engineer's thinking; some of them are part of his language. For Wellington was a master of the memorable sentence. "It would be well," he declared early in his book,

> if engineering were less generally thought of, and even defined, as the art of constructing. In a certain important sense it is rather the art of not constructing; or, to define it rudely but not inaptly, it is the art of doing that well with one dollar, which any bungler can do with two after a fashion.

You will recognize that this statement, in streamlined form, has become a proverb of the profession. And like many proverbs, it is considered by many unreading people who repeat it frequently to be a choice example of native folk wisdom rather than the work of a conscious literary artist. And a conscious literary artist Wellington certainly was; such sentences are not occasional feats for him. Such dithyrambic sentences roar through the book. A few of them drop exhausted at the bottom of the next page, but most of them are self-recharging in their vitality and excitement. Note how he continues from the passage just read:

> There are, indeed, certain great triumphs of engineering genius—the locomotive, the truss bridge, the steel rail—which so rude a definition does not cover, for the bungler cannot attempt them at all; but such are rather invention than engineering proper. There is also in some branches of engineering, as in bridge-building, a certain other side to it, not covered by such a definition, which consists in doing that safely, at some cost or other, which the bungler is likely to try to do and fail. He therefore in such branches who is simply able to design a structure which will not fall down may doubtless . . . be called an engineer. . . .
>
> But to such engineering as is needed for laying out railways, at least, the definition given is literally applicable, for the economic problem is all there is to it. The ill-designed bridge breaks down; the ill-designed dam gives way; the ill-designed boiler explodes; the badly-built tunnel caves in, and the bungler's bungling is betrayed. But a little practice and a little study of . . . geometry will enable anyone of ordinary intelligence without any engineering knowledge whatever in the larger sense to lay out a railway from almost anywhere to anywhere, which will carry the locomotive with perfect safety, and perhaps show no obtrusive defects under what is too often the only test—inspection after construction from the rear-end of a palace car. Thus, for such work, the healthful checks which reveal the bungler's errors to the world and to himself do not exist. Nature, unhappily, has provided no way for the locomotive to refuse to pass over an ill-designed railway as it refuses to pass over an ill-designed bridge.

Working on a grander scale than Frontinus and Eads, Wellington also tackled the problem of accommodating different levels of technical interest in the reader. He had his book set in three sizes of type. The reader who wants only a general treatment need read only the large-type sections. To sample some technical depth, a reader delves into the medium-size print. If he must be comprehensive, he reads even the small face. Each reader makes his own book. Most technical writers today, not concerned about where to shunt a flatcar, will be content with the preface and the introduction which represent splendidly in large type the most vigorous voice in the American literature. But if any writer doubts that vigor in writing can reach down into the deepest technical material, let him read Wellington's small type.

10. Ammann

We come now to the contemporaries. I must confess that, although the weekly mail from the public relations office of D. B. Steinman used to exhort us to read Steinman's writings as a sort of full-time avocation, I have always recommended that we save some time also to enjoy the writings of Othmar Ammann, Herbert Hoover, and Arthur B. Raymond. This is not to disparage the work of Steinman—at least not that work on the level of his masterful paper on the "Design of the Mackinac Bridge for Aerodynamic Stability"—but just to resist his press agent's propaganda that Steinman was the only writer alive, in verse or prose.

Ammann, several of whose bridges have helped make New York a beautiful city, at least from the air and the water, is also a good designer and builder of beautiful reports. Now in his eighties, and still an active senior partner of Ammann and Whitney, he has written more than 100 major reports and papers. His "Tentative Report on the Hudson River Bridge," submitted in 1926, exemplifies the kind of report that technical writers are always urged to write: the kind that comes to the point quickly. Ammann needs only three sentences to state the occasion, aim, scope, and method of attack in his investigation. His fourth sentence introduces his conclusions, which are presented in an order that outlines the body of his report. The "complete and detailed account" that follows ramifies at length each of the conclusions in turn.

Administrators need read only the opening sections to find all they need. Engineers can read the body for the full professional experience. Like the journalist's "inverted pyramid," the engineer's "double report" is a well-designed answer to the ancient problem of different levels of interest.

Ammann casts his ideas in long-span sentences that carry heavy loads with spring and verve. Like most of the major technical writers, he abhors the grey language, or the so-called "objectivity," of the petty technical mind, and honestly translates the quantitative into the qualitative and the "subjective." The data reveal an "intolerable traffic situation." The architect must do justice "to a charming landscape." Explaining why he advocates the suspension-type bridge in the setting of the Hudson River and its Palisades, he says:

> A cantilever bridge, the nearest other possibility, would, with its dense and massive network of steel members, form a monstrous structure and mar forever the beauty of the natural scenery.

Perhaps, after reading Ammann, it will not be surprising to learn that, although in this report he asked for $100,000 to carry on his planning for the bridge, the New York and New Jersey legislatures pledged him $10,000,000.

11. Hoover

Hoover is not a graceful writer. Legendary by now are his struggles to pass English when he was majoring in geology at Stanford University. But he is an excellent example of what deep conviction can accomplish when geared to hard work. To understand what I mean, compare Frederick Taylor to Hoover. Both worked hard at mastering the craft of writing, but Taylor came up only with clarity, while Hoover comes up with emotional strength in everything he writes.

For example, consider Hoover's "Report on the Mississippi Flood," written when he was Secretary of Commerce in 1927. Called upon to explain this national catastrophe and to reassure the public it would not recur, Hoover produced an important piece of well-organized technical journalism. He used comparisons and figures of speech sparingly, but with effect. He saw the river as "caged," restless in its man-made "trough"; freed, it runs at a rate "ten times that of Niagara" over an area "nearly as large as Indiana." But we cannot return this area to "mosquito-swamps"; we must "learn to live with this river." These are the big, simple expressions of a man engaged in an elemental struggle with a force he respects, a man who is all thumbs at subtle embroidery, but strong in hammering out the larger structures of his ideas.

Hoover's description of his profession of engineering—which many people, friends and enemies, feel he should never have left—ranks with the noble descriptions of their sciences by Hippocrates, Vitruvius, and Agricola. Notice how genuine feeling comes through, despite the occasional badly jointed syntax or weak diction:

> It is a great profession. There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.
>
> The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. He cannot bury his mistakes in the grave like the doctors. He cannot argue them into thin air or blame the judge like the lawyers. He cannot, like the architects, cover his failures with trees and vines. He cannot, like the politicians, screen his shortcomings by blaming his opponents and hope the people will forget. The engineer simply cannot deny he did it. If his works do not work, he is damned. . . .
>
> On the other hand, unlike the doctor his is not a life among the weak. Unlike the soldier, destruction is not his purpose. Unlike the lawyer, quarrels are not his daily bread. To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope. No doubt as years go by people forget which engineer did it, even if they ever knew. Or some politician puts his name on it. Or they credit it to some promoter who used other people's money. . . . But the engineer himself looks back at the unending stream of goodness which flows from his successes with satisfactions that few professions may know. And the verdict of his fellow professionals is all the accolade he wants.
>
> With the industrial revolution and the advancement of engineers to the administration of industry as well as its technical direction, the governmental, economic and social impacts upon the engineers have steadily increased. Once lawyers were the only professional men whose contacts with the problems of government led them on to positions of public responsibility. From the point of view of accuracy and intellectual honesty the more men of engineering background who become public officials, the better for representative government.

Note that study of the classics of technical writing has obviously played a part in Hoover's development as an author. Present, among other influences, are some of the stage tricks of Frontinus, Agricola, and Wellington. Incidentally, Hoover is the editor and one of the translators of the English edition of Agricola's "De Re Metallica" and he is the author of "Principles of Mining," a standard text in the first quarter of our century.

12. Raymond

The last writer I shall nominate for your inspirational reading is Arthur E. Raymond, Vice-President of Douglas Aircraft Company, and author of half a dozen major papers and lectures. He reached his due recognition when in 1951 the Royal Aeronautical Society invited him to give the Wilbur Wright Memorial Lecture. To 400 aviation experts gathered in London in the impressive setting of the Third Anglo-American Aeronautical Conference, Raymond offered a working philosophy of technical administration in a paper entitled "The Well-Tempered Aircraft." In the vote of thanks proposed by Society members immediately after the lecture, it was predicted that this paper would become a classic of technical literature.

Raymond set his theme with a bold analogy. "I propose," he said:

> to deal with that particular part of the "state of the art" that has to do with current principles and practices, rules and techniques, that have come to be generally associated with the design and production of well-conceived, well-executed, well-shaken down—that is, *well-tempered* aircraft.
>
> This title has more than a passing relationship to Bach's Well-Tempered Clavichord. The physical laws of musical harmony are essentially mathematical. Two tones whose vibrations are as 1 to 2, . . . or as 3 to 4, are more harmonious together than two whose vibrations are as 1 to 11 . . . but complete adherence to these mathematical laws, even when applied to a device as simple as the piano, would result in an instrument with a far greater number of tones than the piano and one incredibly difficult to play. The great achievement produced by tempering, or shifting slightly, the vibrations of individual tones is that, at an insignificant sacrifice in true harmony, there results a highly practical, highly flexible instrument well within the artistic capability of ordinary humans.

In his paper he drives through to demonstrate that the aircraft manufacturer must compromise between "true extremes" if he is to produce a "practical, highly flexible instrument." Raymond concludes his lecture with a telling anecdote about a technician who explained his approach by saying, "common sense is a rare gift of God. I have only a technical education."

Raymond's "Well-Tempered Aircraft" is itself a well-tempered paper, written by a well-tempered personality who will not, in the name of technical caution and objectivity, surrender the human right to over-all perspective. After reading Raymond, the technical writer or editor cannot again entertain, even in a total lapse of spirit, the notion that to be scientific, writing must be dull.

Conclusions

I remember once reading a book by a certain philosopher in which he considered, one per chapter, the major systems of philosophy. At the end he added a chapter called "Confession of Personal Faith."

But it was entirely unnecessary to read it, and I never met anybody who had, because in the way he had been discussing systems other than his own, he had already betrayed his own beliefs. I am certain that my conclusions are by now no mystery to the reader, but for the sake of getting our discussion off the pad I shall restate them, at least the most important ones.

First of all, I hope that I have convinced some working writers and editors that there is some personal and professional value in studying the classics of technical literature. No matter how superior our age is, it cannot give us the best of everything. If I feel in the mood for music that resolves the chaos of life on a serene note, I have not betrayed my time if I put a Mozart disc on the hi-fi. Actually, Mozart can give me the strength to believe anew in the possibility of serenity even in my own time. And just as Raymond went back to Bach's great revision of the keyboard for his analogy for the well-tempered aircraft, so can we go back to writers of the past for some perspective on our present problems.

What, then, are some of the things that past technical writers can teach us? Beginning with smaller matters of organization and approach, I think they offer for our consideration a great variety of forms, especially in the way of handling definitions and descriptions of process, apparatus, and theory. This consideration of varied forms is important in a day when more and more technical writing is being turned out according to formula.

More important, I think the classics are reminders that even technical writing can be energetic, rhythmical, metaphoric without departing from scientific validity. This is important in a day when technical writing has lost so much of the art of connotation which in good writing must reinforce the science of denotation. Can there be any doubt that this energy, this rhythm, this metaphor, this imagery—in short, this *style*—are functions of the free personality, bringing its whole self to bear on the writing at hand?

But in the sacred temple of scientific objectivity we preach in effect, that technical writing must be grimly impersonal, that the personal pronoun and the adjective necessarily mean distortion and subjectivity, that the analogy is such a sure proof of fallacious approach, that one should not use it even for illustration. And so we encourage the split personality, we inhibit style, and give a professional haven to that bore who, as far as writing ability is concerned, is a perpetual parts-lister.

No one who has ever dipped into the classics of technical writing can have much patience with this approach. And anyone who swears by this impersonal approach has voluntarily converted himself into a timid, inhibited, colorless hack, and has resigned from the human race. I should say, *in my opinion* he has resigned from the human race. But didn't you know it was my opinion?

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The booklet is:

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